"STUDIES ON STABILITY PARAMETERS AND BIOMETRICAL TRAITS OF YIELD AND YIELD CONTRIBUTING CHARACTERS IN LINSEED (*Linum usitatissimum* L.)"

THESIS

SUBMITTED TO

THE BUNDELKHAND UNIVERSITY, JHANSI, U.P. (INDIA)

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

GENETICS AND PLANT BREEDING

By

VIVEK PRAKASH NAGAICH

UNDER THE GUIDANCE OF

DR. S.P. SINGH

READER AND HEAD

DEPTT. OF GENETICS AND PLANT BREEDING

BRAHMANAND MAHAVIDYALAYA, RATH (HAMIRPUR) U.P.

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CERTIFICATE

This is to certify that the thesis entitled **"Studies on stability parameters and biometrical traits of yield and yield contributing characters in linseed (<u>Linum</u> <u>usitatissimum</u> L.)"** submitted to the Bundelkhand University, Jhansi for the award of degree of Doctor of Philosophy in Genetics and Plant Breeding, is a record of bonafied research work carried by ***Mr. Vivek Prakash Nagaich***, under my supervision.

The manuscript pertains to the original work of the candidate. He has worked under my supervision for more than 24 months commencing from the date of his registration as required under the Ph.D. degree ordinance of the University and has put in the required attendance for more than 200 days in the department during that period.

Place: **Rath** **(Dr. S.P. Singh)**

Date: 6.10.2003

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Dated: **(Vivek Prakash Nagaich)**

Chapter-I

INTRODUCTION

INTRODUCTION

Among the different oil seed crops, India ranks first in castor, safflower and sesame in production and is second in groundnut and ranks third, fourth, fifth and sixth in rapeseed-mustard, linseed, soyabean and sunflower respectively (Damodaran and Hegde, 1999). In India, among the oil seed crops grown during Rabi, linseed is next in importance to rapeseed-mustard in area as well as in production. Although it is a non edible oil crop.

Linum the largest genus of Linaceae with about 20 species displays great diversity in Karyotype, morphological and biochemical characteristics. The genus Linum is primarily known for its species Linum usitatissimum as given by Linnaeus, 1857 is under cultivation since prehistoric times in the world for its oil and fibre. It has been cultivated in the area of Mediterranean coastal lands, Asia minor, Egypt, Algeria, Turkey, Spain, Italy and Greece for fibre. In South_West Asia, Turkistan and Afganistan, it is mainly grown for oil. In Asia Minor for oil, meant both for edible as well as industrial uses.

Based on area occupied by linseed in India, the major linseed growing states are Madhya Pradesh, Uttar Pradesh, Maharashtra, Bihar, Rajasthan, Orissa and Karnataka in that order which all together contributes more than 95 percent of the total linseed ~~in~~ area as well as production. During 2000-01 linseed had an area of 590.70 thousand tonnes. In Uttar Pradesh, it had occupied an area of 132.20 thousand hectares with the production of 47.00 thousand tonnes. The average productivity of this crop is less (3.20 q/hect.) which is definitely low as compared to global average. (Annonymus, 2002).

Linseed is basically an industrial oil crop and each and every part of it has got commercial importance. About 20 percent of the seed is directly used for edible purpose in certain pockets of Chhattishgarh state, Chhota Nagpur areas of Jharkhand and some parts of Vidharbha region in Maharashtra and about 80 percent of the oil goes to industries for the manufacturing of paints, varnish, oil cloths, linolin, pad-ink, printing ink, soaps, etc. Recent discovery is the use of linseed oil in processing of cementing roads in USA (Walsh,1965) and antibiotics (Anonymous, 1968) have given it a new importance. Antibiotic "linatime" found in seeds of linseed could cure diseases in men and animals against which no known medical treatment is available. Linseed oil is rich in amega-3 fatty acids knwon to influence blood platelet aggregation, lower blood cholestral concentration and prevent coronary heart disease (Kolodziejczyk (et. al. 1995). The oil cake after extraction of oil is good food for milch cattle and also used as organic manure to maintain the soil fertility as well as to prevent the unwanted microbes with its germicidal properties.

Linseed fibre has equal importance as it is used to blend successfully with wood, silk, cotton, canvas, suiting, shirting and various items for different purposes. After extraction of fibre, the straw is utilized for preparation of straw boards, high grade writting papers and so on. Nevertheless, the rough and strong fibres of linseed is effectively used for preparation of low cost roofing tiles based on convertible polymers. Now, there is more emphasis to evolve double purpose varieties/cultivars which may be capable of producing seed equal to the best seed type and fibre equal to best flax type in the country.

India is the net importer of edible oil and nearly 20 percent of linseed oil, inspite of more than 50 percent linolenic acid contents in oil is used for edible purposes in the country. Now, new vista has been emphasized which has an added advantage of the programme after the CSIRO, Canbara, Australia. It is a plus point hat these varieties carry linolenic acid content less than 5 percent. Therefore, there is a need to formulate the research strategies for breeding linseed varieties for edible (less than 5% Linolenic acid) and technical (Fibre) purposes separately.

Just looking into the fastly growing Indian population, it has been estimated that 26 million metric tonnes of oil will be required by 2001 A.D. to catter the need of the enhanced population. It clearly signifies that there is need to double the oil seed production in order to meet the demand which will be felt by our population in coming years of time. In linseed, average productivity is very less at both country and state level as compared to other oil seeds due to certain reasons which directly/indirectly causes less production. The most possible reason of this low yield of this crop in India is inadequate knowledge of improved technology to the farmers, narrow genetic base, poor adaptability of different strains under different ecogeographical region. In some area as this crop is grown under utera condition. Where very little yield is obtained.

Keeping the above view points research efforts are needed for developing high yielding varieties in linseed. The success of any plant breeding programme depends largely upon the choice of superior parents for hybridization and also knowledge and understanding about the nature and magnitude of gene actions involved besides genetic association of various

characters with seed yield together, ~~therefore~~, several biometrical approaches have been used by several workers. These are line x tester (Kempthorne, 1957). Partial diallel (Kempthorne and Curnew, 1961) and diallel cross (Jinks and Hayman, 1953; Hayman, 1954, 1957, 1958, 1960; Jinks 1954, 1955; Kempthorne, 1956; Griffing 1956 and Gardner and Eberhert, 1966) techniques. Among these diallel cross technique is very convenient method and has been widely used in different crops.

India has greatest agroclimatic diversity therefore, the variety should be evolved with stability of traits possessing wider adaptability in the situation. It is also required to see the impact of different environments on the varieties for identification of stable parents and their progeny for wider exploitation for sustainable production programme.

In order to determine, the stability of the variety some methods have been suggested giving various components (Plaisted and Peterson, 1959; Allard, 1961; Griffing and Langridge, 1963). Regression analysis suggested by Yate & Cockerham (1938) and supported by Finley and Wilkinson (1963) later on and finally suggested by Eberhart and Russell (1966) was used in linseed in measuring adaptability to limited extent.

The linseed crop has not been given due attention, therefore, could not be studied intensively on all the aspects discussed above. The present investigation, "Studies on stability parameters and biometrical traits of yield and yield contributing characters in Linseed (*Linum usitatissimum* L.)" was therefore, designed to derive the informations on the following aspects : To estimate the genetic components of important metric and quality attributes in parental stock and their combinations.

(i) To determine general and specific combining ability variances for all the characteristics in this investigation.

(ii) Determination of general and specific combining ability effects of the parents involved in the study and their progenies in order of sequence.

(iii) Determination of hybrid vigour in F_1 crosses and inbreeding depression in F_2 population with regard to each attribute.

(iv) Estimation of heritability and genetic advance (genetic gain) in respect of all the characteristics.

~~(v)~~ To see the suitability of the genotypes and their adaptability performance (Parents & F_2's) in different environmental conditions.

Chapter-II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Developments in biometrical genetics have led to the formulation of a number of biometrical models for the systematic genetic analysis of metric traits. Application of statistical mathematics to biological problems was primarily initiated by Galton (1889) and continued by Pearson and Lee (1903). The concept that quantitative characters are governed by polygenes was first given by Nilson-Ehle (1909) and that Fisher (1918) was the first who gave the estimation of variance and partitioned it into additive- resulting from average effect of genes; dominance- arising from interaction of alleles at the same locus and epistatic components- emerging from the interaction of alleles at different loci. Wright (1921; 1935) reported that the components of variances were comprised of additive and non-additive types.

Robinson *et al*. (1949) reported that additive genetic variance indicates the extent to which the parents and progenies are related. Mather (1949) found that variance were due to heritable and non-heritable sources. Heritable variance can be further partitioned into fixable and non-fixable types.

Following studies in biometrical genetics have led to the development of various concepts for the estimation of genetic parameters.

(i) Estimates based on segregating generations from crosses of two pure lines (Mather, 1949).

(ii) Covariance of half-sibs and full-sibs (Comstock and Robinson, 1948; 1952; Anderson and Kempthorne, 1954 and Kempthorne, 1957).

(iii) Diallel analysis (Jinks and Hayman, 1953; Hayman 1954a and 1954b; Griffing, 1956; Eberhart, 1964; Gardner and Eberhart, 1966; Jensen, 1970).

(iv) Partial diallel (Kempthorne and Curnow, 1961; Fyfe and Gilbert, 1963; Federer, 1967; Bray, 1971 and Ponnuswamy, 1972).

(v) Triple test cross (Kearsey and Jinks, 1968; Ketata et al. 1976).

(vi) Triallel and quadriallel analysis (Rawling and Cockerham, 1962).

A brief review of literature available on the following aspects to cover the objectives of the present study is given below.

(1) Diallel analysis

(a) Variance component study.

(b) Combining ability study.

(2) Average degree of dominance.

(3) Heterosis and inbreeding depression

(4) Heritability and genetic advance analysis.

DIALLEL ANALYSIS

The Diallel cross mating system is one of the most important and widely used biometrical technique. Schmidt (1919) first of all named the term "diallel" to denote each group of female was crossed with each of males. Hayman (1954 a)

defined it as "the set of all possible mating between several genotypes" Hull (1946), Jinks and Hayman (1953) and Hayman (1954a) developed the method for estimation of genetic components of variance from diallel crosses.

The basic assumptions of diallel analysis of Jinks and Hayman, 1953; Hayman, 1954a, b; Jinks, 1954 and Allard, 1956 are :

(1) Normal diploid segregation

(2) Absence of reciprocal differences

(3) Absence of epistasis

(4) No multiple allelism

(5) Homozygosity of parents and

(6) Independent distribution of genes among parents (absence of correlated gene distribution).

The failures of one are more of the above assumptions leads to invalidation of the estimated components of genetic variance to some extent. Dickenson and Jinks (1956) examined the mathematical consequences of failure of these assumptions. Jinks (1956) extended the diallel to heterozygous parents. The diallel cross was further used to cover autotetraploids by Dessureaux (1959), Gardner and Eberhart (1966) suggested the model for a fixed set of random-mating population. Johnson (1953) discussed elaborately about the field application of diallel cross technique in plant breeding.

Another approach to analyse the diallel cross data in order to partition the total genotypic variance into additive and

non additive components was out lined by Fisher (1941). In this context, the concept of component analysis of variance and general and specific combining ability was postulated by Sprague and Tatum (1942) as a measure of gene action, which is in fact very important to the breeders. They defined general combining ability as the average performance of line/lines, in a series of hybrid combination while specific combining ability is the combinations which do relatively better or poor that is expected on the basis of average performance of the lines involved. General combining ability includes additive genetic variance and additive x additive interaction variances. Specific combining ability on the other hand reflected non-additive genetic portion, arising from dominance and epistatic deviations. Griffing (1956a,b) gave three models (fixed, random and mixed), each with four methods for working gca and sca estimates in a set of diallel crosses and showed the relationship of diallel crossing method to Fisher's (1918;1930)method of covariance between relatives as expressed in terms of additive and non-additive genetic variances.

Many other methods have been designed to estimate the gca and sca effects of different materials. Out of these, inbred x variety or top cross method proposed by Jenkins and Brunson (1932), polycross by Tysdal *et al.* (1942), line x tester mating designed by Kempthorne (1957) and partial diallel (Kempthorne and Curnow (1961) are note worthy.

GCA indicates the nicking ability of parents. Like wise, SCA effects help to short out the superior crosses for yield and other desirable characters which could be used further in a breeding programme to exploit transgressive segregants.

Diallel analysis is the quickest method of under standing the genetic nature of quantitatively inherited traits and it also helps in determining the genetic prepotency of parents. The evaluation of a set of F_1 can provide several estimates required studying the genetics of the breeding materials. A brief review of literature on linseed pertaining to gene action, combining ability and genetic components of variances is furnished as under.

ANALYSIS OF GENETIC PARAMETERS

The phenotype of any plant can be expressed as a linear function of the individual genotype and the environmental effect (Falconer, 1960). The influence of environment is not the same over all the genotypes. Some are more or less sensitive while other stable. This is due to interaction between genotypes and environments. On expanding the function, the phenotypic value (P) may expressed as:

$$P = G \times GE + E.$$

Where G is the genotypic value, GE is the genotype x environment interaction effect and E is the environmental effect.

While making the genetic analysis of quantitative attributes, Fisher (1918) partitioned the heredity variance (genotypic value) into additive, dominance and epistatic components. Wright (1935) defined these components as additive genetic variance, variance due to dominance and variance due to deviation from additive scheme resulting from the interactions of non-allelic interactions.

Cockerham (1954) and Kempthorne (1956) further partitioned epistatic variance into factorial components of digenic and higher order of interactions suggested as additive x additive, additive x dominance and dominance x dominance for the two loci situation and additive x additive x additive etc for three loci and so on.

Griffing (1956) pointed out that gca involved additive effects and additive x additive interactions. Sprague *et al.* (1959), Carnahan *et al.* (1960), Sprague (1966) and Gilbert (1967) also confirmed the above findings.

Kempthorne (1957) precisely defined the gca and sca in terms of variance, half sibs and full sibs, respectively which is analogous to Design II of Comstock and Robinson (1948,1952).

Gardener (1963) studied and listed the following genetic parameters of breeding value :

(1) Additive genetic variance (σ^2 A) which arise from the additive effects of the genes at all the segregating loci.

(2) Dominance genetic variance (σ^2 Dpi.) which results from inter allelic interactions of genes.

(3) Epistatic genetic variance (σ^2 Epi.) which comes from inter allelic interaction of genes at two or more segregating loci and it can be divided into additive x additive (σ^2AA), additive x dominance (σ^2 AD) and dominance x dominance (σ^2 DD) for two loci and into additive x additive x additive (σ^2 AAA) etc for three or more loci.

(4) Average degree of dominance or ratio of dominance variance to additive genetic variance.

(5) Genotype-environmental interaction which can be divided into additive genetic variance x environmental variance and non-additive genetic variance x environmental variance.

(6) Genotypic correlation among quantitative traits of importance for particular crop.

GENE ACTION BASED ON COMPONENT OF VARIANCE

Yates (1947) developed the concept of diallel cross in *Trifolium hybridium* in a set of (n^2) possible single crosses and selfs between homozygous lines.

Jensen (1970) and Redden and Jensen (1974) suggested that out crossing and concurrent selection is a worthwhile tool for breeding the naturally inbred crops. They advocated the importance of additive component of genetic variation. Miller and Rawllings (1967) and Meredith and Bridge (1971) concluded that intermediate population could provide a better core material for selection than original F_2 population, probably due to partial break-up of linkage block (repultion phase) in the original material.

Pederson (1974) recommended that bidirectional selection as against unidirectional should be preferred as method of increasing the frequency of desirable homozygotes.

Sneep (1977), Stam (1977) and Bos (1977) demonstrated that in self pollinated crops, inter-mating in early generation would leads to genetic drift.

Jatasra and paroda (1979), while studying certain traits in wheat, observed that both the additive and non-additive type of gene actions were involved in determining such traits. The gca/sca ratio more than unity indicated the performance of additive type of gene action. They advocated the~~se~~ use of *per se* performance of crosses instead of their SCA effects ~~of~~ for selecting best specific cross combinations .In further experiment conducted in (1981), they observed that the mean performance of the varieties could be predicted across environments, as it appeared to be associated with linear components of G x E interactions, whereas no such relationship of non-linear components with mean performance as well as regression coefficient was evident. In case of grain yield, F_1s were more responsive than the segregating generations.

A very brief work has so far been conducted on the inheritance of quantitative characters in this crop however, work done on the nature of gene action through genetic component of variance analysis are reviewed here.

Joshi et al., (1961) studied the nature of genetic control for there taking to first flowering in linseed varieties using diallel cross technique and observed that 'D' values (additive effects) were highly significant while; 'H' values (dominance effects), though relatively lower in magnitude were also significant.

Anand et al., (1972) studied 60 hybrid combinations and observed that the parental lives differed in general combining ability but the variation could not be related to phenotypic differences. Additive gene action was found to be predominant for flowering time and height at branches whereas

non-additive effects were predominant for all the other characters understudy.

Mishra (1977) observed additive genetic variance for days to flowering, plant height and seeds per capsule and non-additive genetic variance for number of branches per plant, days to maturity, number of capsules per plant, 1000-seed weight, yield per plant, length in days to reproductive phase, oil content and iodine value of oil in linseed crop.

Doucet (1978) observed partial dominance for stem length, seed yield and 1000-seed weight and total dominance for number of capsules per plant and seeds per capsule. He also found additive gene effects as significant for stem length and 1000-seed weight but epistasis was significant for seed yield.

Singh and Singh (1979) stressed the importance of both additive and non-additive variance for oil content and additive gene effects as for 1000-seed weight.

Bhatnagar and Mehrotra (1980) with 8 parental diallel (excluding reciprocals) in linseed noted the importance of both additive and non-additive types of gene action for oil content.

Wicks (1980) reported the presence of epistasis in respect of days to flowering, seed yield, seed weight and oil yield per plant. Some of the characters were found to be controlled by additive gene action.

Doucet and Filepescu (1981) found both the additive and unidirectional dominance as significant for oil content and linoleic acid while additive effects were significant for oleic,

linolenic and total saturated fatty acids only. They emphasized that high oil content, high linoleic acid and linolenic acid were controlled by recessive genes and oleic acid was controlled by dominant genes. Non- allelic interaction was also evident for linolenic and oleic acid content.

In (1982) they observed dominance x additive effects for oil content and oleic, linoleic and linolenic acid. Additive effects were predominant for oleic and linolenic acid; partial dominance was observed for oil content, oleic and linolenic acid. Whereas, almost total dominance was observed for linoleic acid content.

Kumar and Chauhan (1982) conducted the study in F_2 generation of a 10 parent diallel of linseed and reported high variance for general combining ability in case of plant height, capsules per plant and branches per plant and predominant additive gene action for seed yield.

Rao and Singh (1984) in their experiment found that additive gene action were predominant for all the characters studied except plant height and days to maturity. They also suggested that additive-dominance model was fit for primary branches per plant, seeds per capsule, 1000-seed weight and seed yield per plant.

Sharma (1986) studied F_1 and F_2 generations in a set of diallel for yield and some of its components and found non-additive gene effects as significant for all the characters except capsules per plant and seed yield in F_1. Additive gene action was predominant for plant height and 100-seed weight

but dominance components were more important for the other characters.

Rao and Singh (1987) reported additive, dominance and epistatic effects in six crosses of linseed suggesting that additive and dominance effects being important contributed more in the expression of yield and its components.

Tak and Gupta (1989) derived information about components in 18 generations including parents of the crosses Himalini x Flake-1, KL-134 x LCK–69 and Neelum x Ayogi and reported additive and non-additive gene effects in the experiment and dominance effects were found predominant in most of the cases. They also suggested reciprocal recurrent selection method for improving seed yield.

Gorey *et al.* (1990) observed additive genetic variance for controlling seed yield and plant height and remaining traits by non–additive genetic variance.

Khorgade *et al.* (1992) observed that additive genetic was important for expression of capsules/plant, seed yield/ plant and 100 seed weight.

Mishra (1992) found additive genetic variance as predominant for days to flowering and days to maturity in both the generations. The characters days to germination and oil content in F_1; plant height, seeds per capsule, tillers per plant, capsules per plant, 100-seed weight and yield per plant in F_1 and F_2 displayed dominance variance to be more for these traits. Average degree of dominance showed that days to germination in F_2 and days to flowering in F_1 and F_2 showed partial dominance.

Tak (1994) reported that seed yield was mainly controlled by duplicate gene while for fibre and oil content, complementary gene effects were more important. He further concluded that by and large there was predominance of non-additive gene action for these traits, although additive gene action was also pronounced.

Popescu et al., (1995) reported that both additive and dominance gene effects appeared to be involved in control of flowering duration. But dominance effects predominantly acted in accordance with another dominance model.

Tak (1996) investigated components of gene effects in 18 generations from each of the crosses, Himalini ×Flake-1, KL-134×LHCK-69 and Neelum × Ayougi. Dominance gene effects were important for seed yield per plant, primary branches per plant and plant height. However, additive gene effects occurred for seed yield per plant, capsules per plant and primary branches. All gene effects (additive, dominance and epistatic interaction) were involved in the crosses at the digenic and trigenic levels for most of the attributes.

Wang et al., (1996) studied nine parental diallel in flax for plant height, technological length, branch numbers, capsule numbers, fibre length, fibre weight per plant and reported that the variances of GCA and SCA were highly significant for all the characters studied suggesting that both additive and non-additive gene effects are important for controlling these traits.

Patel and Gupta (1997) observed, that additive and dominance components were significant for days to flowering,

days to maturity, plant height, capsules per plant, 500-seed weight, harvest index and seed oil content. Only dominance components were significant for seeds per capsule and biological yield. The degree of dominance indicated preponderance of additive genetic variance for days to flowering and days to maturity equal importance of both genetic components for 500 seed weight and seed oil content and greater magnitude of dominance component for rest of the characters.

Patel. et al. (1997) reported the importance of both additive and non-additive type of gene action in the inheritance of all the characters studied. However, the preponderance of additive components was observed for phenological traits (days to flowering, days to maturity); equal importance of both additive and dominance components for plant height, primary branches per plant, 500 seed weight and seed oil content and preponderance of dominance components was observed for number of capsules per plant, seeds per capsule, seed yield per plant, biological yield per plant, harvest index and oil yield per plant.

Yadav and Gupta (1999) revealed the presence of both additive and non-additive gene effects. Over dominance was involved for number of tillers, number of branches, seed yield, oil content, harvest index and iodine value in both the generations. Over dominance was also involved for days to 50% flowering, plant height, days to maturity and 1000 seed weight in the F_2 generation. Complete dominance was observed only for 1000-seed weight in the F_1 generation. However, partial dominance was recorded for the rest of the traits, but the degree of dominance observed in both the generations was

inconsistent. The preponderance of dominant genes was observed for expression of days to 50% flowering, plant height, days to maturity and iodine value in both the generations and 1000-seed weight and seed yield in the F_2 generation.

Sakhovich-VI (1999) reported that over dominance was noted in the control of technical length of the stem and number of seeds per capsule, while additive gene effects were noted for number of capsules per plant.

Kumar et al. (2000) reported non-additive gene action as predominant for all the traits except plant height.

Yadav et al. (2000) reported high magnitude of gca and sca effects indicated the involvement of both additive and non-additive gene interactions, respectively for inheritance of different characters. Parents, Garima, Laxmi-27 and Neelum were judged to be better general combiners for seed yield and they showed good combining ability for most of the characters as well. The common crosses on the basis of both heterotic response as well as sca effects in relation to gca effects were Neelum x T 397, Neelum x ES 44 and Garima x Neelum. Other crosses, Garima x ACC No. 692, Laxmi 27 x LCK 88062, ES 44 x LCK 88062 and RL 904 x ACC No. 692 manifested high heterotic response coupled with high sca effects, mean and significant gca effects of the parents involved. The crosses exhibited preponderance of additive x additive gene effects and other crosses revealed additive x dominance and dominance x dominance gene effects.

COMBINING ABILITY ANALYSIS

The concept of general and specific combining ability effect as a measure of gene effect was proposed by Sprague and Tatum (1942). They defined general combining ability as an average performance of a line in a series of crosses and specific combining ability referred to those cases in which certain cross combinations do relatively better or worse than the expected ones, on the basis of average performance. They concluded that gca is primarily due to additive effects of genes, while sca is a consequence of intra-allelic interaction or dominance and inter-allelic interactions as epistasis and so on.

Handerson (1952) considered gca as the average merit with respect to some traits or weighted combinations of traits as indefinitely large number of progeny of an individual line when mated in a random sample from some predicted population under a specific set of environment. He defined sca as deviation of average value of cross from the value, which would be expected on the basis of known gca of two lines.

Rajas and Sprague (1952) while studying the interaction of gca and sca with locations and year, reported that the variance due to sca (6^2s) was greater than the variance due to gca (6^2g). This clearly indicated that the variance of sca includes not only the non-additive deviations due to dominance and epistasis, but also a considerable portion of GXE interaction.

Hayman (1957) observed that in the absence of epistasis, gca comprised additive portion while sca involved dominance. Both the combining abilities, therefore, retain the

epistasis portion while sca is measure of dominance and epistasis in unselected and selected materials respectively.

Moll *et al.* (1960) indicated that the magnitude of gene action based on combining ability variance is not much reliable due to serious biasness from genotype x environmental interaction.

Anand and Murty (1969) studied the genetic control of 7 quantitative characters in linseed involving 10- parents. They observed significant general and specific combining ability as well as reciprocal effects for all the attributes of yield.

Badwal and Gupta (1970) observed that general combining ability is predominant for all the yield components, where as for yield, specific combining ability effect to be more important in linseed crosses.

Shehata and Comstock (1971) reported general combining ability effects to be highly significant as compared to specific combining ability for the characters under study at all the densities in linseed

Kalia (1972) reported that the variances due to both general and specific combining ability were important for oil content, 100-seed weight, number of seeds per capsule, primary-branches, secondary -branches, days to 50 per cent flowering , plant height and days to maturity but for seed yield and number of capsules per plant general combining ability variances were less important.

Rasbasco (1973) studied combining ability for oil content and iodine number from a diallel cross between 10

Argentinian cultivars. Analysis of variance showed that values for specific combining ability were lower than general combining ability and variances for specific combining ability was less in *'Puelche'* than in others in respect of oil content. A positive correlation was found between the mean values for a given parent and its general combining ability.

Al-terfah (1974) found that relative magnitude of general combining ability variance was higher and therefore, more important for plant height, primary-branches, secondary-branches, seeds per capsule, percent oil and 1000-seed weight. However, the relative magnitude of general combining ability and specific combining ability variances was almost the same for grain yield.

Kaushal *et al.* (1974) studied combining ability in a diallel set of 10 varieties of linseed. Both general and specific combining ability variances were significant but the magnitude of specific combining ability variance was 14 times more than that of general combining ability variance. R-17 and T- 397 showed significant general combining ability effects.

Rai and Das (1974) while working on six yield contributing characters in five linseed varieties concluded that the variance due to both general and specific combining abilities were significant for all the characters. They further reported that gca variance was of larger magnitude than that of sca variance. Specific combining ability effect was limited in almost all the traits of crosses studied.

Patil and Chopde (1981) evaluated a 10 x 10 diallel in F_2 generation grown at three different locations for yield and

four yield components. Both general and specific combining ability mean squares were found as significant at all the three locations for all the traits. In the same study, significant ratio of gca and sca mean squares indicated the predominance of additive gene effects. The higher gca values than that of sca values reflected the presence of large component of additive x additive and epistatic variance. Authors further concluded about the possibilities of effective selections for all the traits.

Dang *et al.* (1987) studied general and specific combining ability effects in 49 crosses of seven varieties/lines and reported that the inheritance of oil content was controlled by both additive and non-additive genes. Zhavgya-1 and 75-17 with the highest and second highest content (41.1 and 39.9 per cent oils respectively) showed the highest gca, while the variety 77134-269 had lowest content (35.1%) and Swiss Red (35.5%) showed lowest gca. Most of the combinations showed high sca involving one parent with high gca effect.

Thakur *et al.* (1988) studied a diallel set involving 8 linseed varieties and indicated that DPL-21 and Himalini were the best general combiners for various yield components. The best specific combiners for seed yield, number of capsules and tillers per plant were, Flake-2 x BS-2 and Himalini x TLP-1.

Manfroni *et al.* (1989) while studying combining ability for 6 yield related characters in 5 linseed varieties found that the varieties Reconquesta INTA and CI 2703 were most suitable parental types. In general variety Alcorta INTA showed significant positive gca for oil content and significant sca in crosses with Tape Parana INTA and CI 2828. gca of Tape Parana INTA was positive and significant only for seeds per

capsule, while the sca for this characters was significant in a cross with Reconquesta INTA variety CI 2838 showed significant gca.

Singh *et al.* (1990) while studying combining ability on 6 yield components in 10 linseed varieties and their 45 F_1 hybrids, reported that Neelum and EC 41583 were the best general combiners for seed yield

Niu *et al.* (1991) studied combining ability in NCD II with flax and reported that gca and sca appeared highly significant for all the characters studied with the exception of seed weight per plant and seeds per capsule. The gca variance ($\sigma^2 g$) of the population was greater than sca ($\sigma^2 s$) for the other characters. The $\sigma^2 g$ of seed weight per plant (23.84%) was lower than its $\sigma^2 s$ (76.1%) suggesting that non -additive effects were more important than additive effects.

Mishra (1992) reported that the magnitude of gca and sca variance, for all the traits indicated that both additive and non-additive gene action were involved in expression of these traits. The ratio of σ^2 gca/σ^2 sca for days to flowering in F_1 and F_2 were around unity indicating the importance of both type of gene actions

Khorgade *et al.* (1993) worked out combining ability for eight yield related characters in 21 F_1 hybrids of linseed resulting from the crosses between 7 diverse lines (TLP-1, JLS (J) 1, R 17, AKL-33, LMH 300, LMH 354 and C 219-1-1) and three well adopted testers (T-397, SPS 77-23-10 and C-429) analyzed during *rabi* 1989-90.

Popescu <u>et</u>. <u>al</u>. (1995) conducted an experiment with 9 varieties (2 flax, 5 linseed and 2 D.P.) and their hybrids from a half diallel set at three crop densities and reported that both additive and dominance gene effects appeared to involved in control of the duration of flowering period but dominance effects were predominated and acted in accordance with an over dominance model. Estimates of narrow sense heritability were fairly high for the trait, which were not correlated with seed yield.

Pillai <u>et</u> <u>al</u>. (1995) analyzed combining ability in eight diverse cultivars of linseed. The analysis revealed that both gca and sca variances were highly significant for all the characters except tillers per plant due to sca. However, the general predictability ratio indicated predominance of additive components for days to maturity, number of tillers per plant, capsules per plant, seed yield per plant, 100 seed weight and plant height.

Mishra and Rai (1996) conducted an experiment in a diallel set of 10 diverse linseed varieties grown in 4 environments. A highly significant variation was observed for GCA and SCA × E for all the characters, and SCA and SCA × E for all the traits except oil content. Among the parents T397 proved to be a good general combiner for seed yield/ plant, Neelum for palmitic acid and stearic acid contents, LCK152 for oil, linolenic acid and reduced linolenic acid contents, LCK185 for high linolenic acid and reduced linolenic acid contents, and LC185 for high linolenic acid. SCA effects were high in SPC 23 × LC 185 for seed yield/ plant and oleic acid and reduced linolenic acid contents, Sweta × LCK 152 for palmitic acid and oleic acid

contents and Neelum × R 17 for iodine value and higher linolenic acid contents.

Patel *et al.* (1998) reported that both GCA and SCA were influenced by environment suggesting the necessity of tests over a wide range of environments for unbiased estimates of GCA and SCA. Chambal and Triveni were identified as good general combiners for seed yield and oil content, earliness and other yield components. LCK 88511 × Triveni exhibited high SCA effects for seed yield, earliness, oil content and other yield contributing characters.

Tewari (1999) reported that Shubhra was good general combiner for nine characters whereas, T 397 was good general combiner for seven characters. On the basis of gca effect the good general combiners, common in both the generations were, Shubhra, NL-93 and T 397 for early flowering and maturity; NL-93, Shubhra and Garima for plant height and technical plant height; Shubhra and RL-914 for tillers per plant; Shubhra for branches per plant; T 397 for capsules per plant; T 397 and Neelum for seeds per capsule; LCK 87132, T 397 and Shubhra for yield per plant; Neelum, LCK 89512, NL-93 and LCK 87132 for 1000-seed weight; Shubhra and LCK-89512 for oil content; LCK 88062 and LCK 88312 for palmitic acid, stearic acid, oleic acid and linolenic acid.

The results of specific combining ability indicated that non of the cross is best specific combiner for all the characters. However, in respect of seed yield, 19 crosses in F_1 and 17 crosses in F_2 exhibiting significant and desirable sca effects, involved all the three possible combinations between the parents of high and low gca effects. Cross combination Shubhra

x LCK 88062 and Shubhra x LCK 87132 in F_1 generation came in first category (high x high) involving both parents having high gca effects for seed yield. While Shubhra x LCK 87132, Neelum x Shubhra and T 397 x Shubhra (high x high) in F_2 generation. T 397 x Neelum in F_1 generation and Shubhra x LCK 88062, T 397 x LCK 88062 and Neelum x 88312 in second category (high x low in F_2 generation and Garima x LCK 89512 in F_1 and LCK 89512 x NL-93 and RL 914 x LCK 88062 in third (low x low) category indicating additive and non-additive gene effect respectively.

Kumar *et al.* (2001) observed that the line LCK 8527 was good general combiner for seed yield, capsules per plant, seeds per capsule, harvest index and oil content; whereas, R 552 among testers was good general combiner for seed yield, early maturity, primary branches per plant and harvest index. T 397 and DPL 17 were good general combiners for seed yield along with seeds per capsule.

Yadav and Srivastava (2002) reported that variety Garima was good general combiner for early growth vigour, days to 50% flowering, days to maturity and seed yield per plant. Crosses, LCK 8528 ×ES 44, Garima × ACC. No. 692, Garima × T 397, Neelum ×T -397, Laxmi 27 × LCK88062, ES 44 ×LCK88062, RL 904 × Acc. No. 392 and RL 904 ×LCK 2023 were good specific combiners for both F_1 and F_2 generations.

HETEROSIS AND INBREEDING DEPRESSION

1.Magnitude of Heterosis :

Heterosis was recognized by Koelreuter as early as in 1763. Originally the classical term heterosis was coined by Shull (1914) implies the excellence of F_1 over strictly homozygous

parents involved in its formation. However, according to Hayes, Immer and Smith (1952) both the terms are now used and thus these are synonymous to each other.

Stebbins (1957) defined heterosis as greater adoptness to human needs which has been obtained in a particular environment through artificial selection after hybridization.

Fonseca and Petterson (1968) described heterosis as an improvement of heterozygotes in relation to better parents. Mather and Jinks (1971) defined heterosis as the amount by which mean of an F_1 family exceeds its better parent.

2. Genetic Basis of Heterosis :

The alternative genetic hypothesis explaining the phenomena of heterosis differs primarily in the role of favourable dominant genes, over dominance, epistasis and even sort of physiological stimulus in heterozygosity *per se.*

Among various genetic theories, dominance hypothesis was independently proposed by Davenport (1908), Bruce (1910) and Keeble and Pellow (1910), whereas over dominance hypotheses was proposed by Shull (1908) and East (1908). Both the hypothesis held good ground for practical breeders in order to obtain maximum return. Studies on heterosis aimed at analyzing the nature of combining ability in relation to hybrid vigour in order to obtain the genetic basis for development of an appropriate and precise breeding methodology.

3. Exploitation of Heterosis:

The study about the manifestation of heterosis in cross as well as in self pollinated crops was conducted by Sprague and Tatum (1942), Rajas and Sprague (1952), Whitehouse et al. (1958), Lupton (1961), Ahluwalia et al.(1962) Fonseca and Petterson (1968), Tandon et al. (1970) and Verma and Rajnanujam (1975).

4. Inbreeding Depression :

Inbreeding is the mating between individuals related by descent or ancestry. Inbreeding depression has been recognized by man for a lay time. It may not be surprising in view of the harmful effects produced by inbreeding. In many societies, marriages between closely related individuals have been prohibited since early time. Hindu societies perhaps present the extreme example where marriages between individual related by ancestry, up to maximum distant, is prohibited. Inbreeding depression was noticed as early as in 1876 by Darwin (Cross and Self Fertilization in Vegetable Kingdom). It is measured as coefficient of inbreeding which is probabily that two genes at any loci in an individual are identical by descent. Wright (1922) symbolized its coefficient as "F" and defined as the correlation between uniting gametes.

Inbreeding coefficient of any generation would be :

$$F_N = (\tfrac{1}{2}{}_N) + 1 - \tfrac{1}{2}{}_N) F_{N-1},$$

Where,

'N' is the number of breeding diploid individuals. The information regarding inbreeding coefficient permits to measure the rate at which homozygosity would be attained. It also helps

in estimating the extent to which mating between gametes in a population of limited size departure from that of ideal panmictic or out bred population in which two alleles of an individual are not related. Accumulation of deliterious and harmful recessive genes in an inbred line makes it very weak, all of which can not be removed with any amount of selection pressure. Therefore, decrease in vigour, survival value and ultimately its yield is almost in vital consequence of inbreeding (Allard and Handerson 1964).

One of the characteristic of heterosis is that the increased vigour is expressed in F_1 generation exclusively. There is considerable depression as a consequence of inbreeding in F_2 and subsequent generations. The extents of such depression in the same crop varied from character to character, generation to generation and also the genotypes themselves. East (1908) observed that the genes for height were fixed after five generations of inbreeding while, yield is continued to decline for 20 generations. Generally, the depression is rapid in first few generations and slow down in later.

In self-pollinated species homozygosity is the normal condition for most of the genes are recessive and deletorious. Gene mutants are contributed in homozygous condition and soon after they get eliminated promptly. These species become adapted to homozyosity and develop genetically in a balanced condition. Mather (1943) called it "homozygous balance".

A brief review of literature relating heterosis and inbreeding depression in linseed is illustrated as under.

Daskalov (1963) concluded that estimated heterosis in F_1 was the combined expression of genetical, cytoplasmic, biometrical and physiological factors and might be attributed to estimation resulting from the interactions of different heritable factors of the parents and F_1s. Turbin (1963) introduced the concept of genetic balance which accounted for not only the interaction between hereditary, but also the environmental factors.

Rowe and Andrew (1964) and Singhania and Rao (1976) observed that linear component of GxE interaction was greater in the parents than in F_1; the F_1 hybrids were reported to show higher mean performance than that of their respective parents indicating that the heterosis was associated with greater sensitivity to the environment. Allard (1956), Bouman (1959), Dickinson and Jinks (1956), Hayman (1954b, 1963), Jinks (1954,55), Jinks and Jones (1968), Kempthorne (1956), Graffius (1959)and Eberhart (1964) demonstrated the correlation between heterosis and epistasis.

Robinson (1963) and Moll *et al.* (1964) suggested that genetic diversity of parental stocks and partial to complete dominance of the genes, might be the major factor for heterosis in yield and its components. Williams (1959), Durate and Adams (1963), Graffius (1964) and Coyne (1965) explained that studies of individual component could express manifestation and the genetic exploitation of heterosis.

Carnahan (1947) studied 16 crosses involving eight parents and observed 40 per cent hybrid vigour over the parental mean in *Linum*.

Dubey (1967) studied seven morphological characters including yield of 36 hybrids and reported that the hybrids attain as high as 230.93 per cent increase over the better parents.

Sehata and Comstock (1971) observed heterosis among cultivars using diallel and noted 6 per cent heterosis in F_1 over mid parent. Four F_2 populations were found to be high yielding in the material studied than their parents.

Anand _et al._, (1972) while studying 60 hybrid combinations observed heterosis to be apparent in 6 out of 7 morphological characters.

Choudhury _et al._ (1972) noted that F_1 for seeds per capsule to be lower than the mid parental values while the values for 100-seed weight and seed yield per plant were higher.

Galkin (1973) reported 15 per cent heterosis for seed yield, 51 per cent for capsules per plant and12 percent for 1000-seed weight. He further explained the extent of heterosis to be greatly influenced by agronomical condition and parental forms.

Bhatnagar and Mehrotra (1979) observed the heterosis in F_1 as compared to better parent in linseed for iodine value ranging from 6.69 to 7.59 per cent.

Patil and Chopde (1983) studied from a diallel cross and observed highest heterosis with regard to better parent as 89.81 per cent for seed yield, 65.5 per cent for capsules per plant and 63.2 per cent for tillers per plant.

Dakhore *et al.* (1987) observed highest heterosis over the standard check for seed yield per plant (52.32%), 1000-seed weight (12.36%) and branches per plant (42.30%).

Saraswat and Kumar (1993) conducted diallel study on 12 accessions and observed high degree of heterosis for seed yield in the crosses L-27 x LC –1010 and SPS –2310 x LCK 152.

Mishra and Rai (1993) studied the extent of heterosis and relative magnitude of general and specific combining ability and reported that the extent of heterosis over better parent indicated that seed yield was most heterotic character followed by stearic acid, linoleic acid and protein content. Cross SPS-2310 x IC 185 was found most heterotic for seed yield and oleic acid.

Verma and Sinha (1993) determined heterosis over mid parent and better parent for 8 quantitative traits in hybrids from 42 crosses under irrigated and rainfed conditions and observed significant heterosis for seed yield in 20 crosses related to better parents while they found corresponding figures under rainfed regime being 27 and 20 crosses, respectively.

Wang *et al.* (1996) studied 8 parental diallel crosses in flax and observed that heterosis values averaged 5.94 per cent for plant height, 7.38 percent for technological length, 16.77 per cent for branch number, 20.87 per cent for capsules number, 9.57 per cent for fibre rate and 19.3 per cent for fibre weight per plant.

Yadav (1997) reported significant positive heterosis over economic parent for seed yield in twelve crosses. Majority of the hybrids also exhibited desirable and significant sca effects.

Crosses Neelum × T 397 (85.13%), Garima × Neelum (83.25%) and Garima × T 397 (74.40%) showed maximum heterotic response for seed yield and its related traits. He further observed the high <u>per se</u> performance for these crosses. Maximum heterosis for oil content (7.86%) were found in crosses Laxmi 27 × T 397 coupled with Neelam × Laxmi 27. Significant inbreeding depression for seed yield was also noted in 24 crosses. Increase in seed yield was found due to non-additive genetic component as manifested by the preponderance of dominant genes for high yield in this study.

Yadav (2001) observed pronounced hybrid vigour for yield and most of the yield components. Out of 45 different hybrids eight hybrids were identified as promising for many desirable traits. Heterosis to the extent of 82.91percent over the economic parent T397 was recorded for seed yield per plant. Crosses between high x high and high x low GCA parents exhibited greater heterosis. Heterosis for seed yield was generally accompanied by heterosis for yield components.

HERITABILITY AND GENETIC ADVANCE

Heritability is one of the most important direct selection parameters which determines whether the phenotypic differences observed among the various individuals are due to differences in their genetic make up or simply the results of environmental factors. Heritability is an index of transmissibility of traits from parents to their offspring.

Lush (1940) suggested the following uses of heritability estimates:

(a) When heritability in narrow sense is high, emphasis should be placed mainly on mass selection and if it is low, more pressure should be given on pedigree, sib tests and progeny tests.

(b) In case where epistasis variance is relatively high emphasis should be placed an selection between families and line breeding.

(c) If over-dominance is strong, inbreeding programme is to be emphasized with an objective of commercial hybrid production.

(d) When the variance due to interaction between genotype and environment is relatively large breeding programme should be extremely lined up the development of superior varieties for different agro-climatic regions.

Heritability in narrow sense could be utilized for estimation of expected improvement based on selection. Whereas, the genetic advance is another parameter which helps breeders in estimation of the gain through selection pressure.

Comstock and Robinson (1952) defined that genetic advance is an improvement in the genotypic value in the new population as compared to the original one and depends upon the following three factors :

(1) The amount of genetic variability such as the magnitude of the differences among different individuals in the base or initial population.

(2) The magnitude of the masking effects of the environmental and interaction components of variability on the genetic diversity.

(3) The intensity of selection which is being applied.

Few important literature available on heritability and genetic advance in linseed is mentioned here as under:

Chaudhary et al. (1972) calculated heritability, genetic advance and various other components of variation influencing yield in *Linum* and concluded that additive genetic variance and expected genetic gain were high for capsule numbers, seeds per capsule and 1000-seed weight.

Dayal et al. (1975) recorded wide range of genetic and environmental variation for several characters in 21 linseed varieties. The genotypic coefficient of variation and heritability estimates showed the variability to be operative for days to flowering and maturity, plant height, 1000- seeds weight and seed yield per plant which were highly heritable due to the additive gene effects in respect of these characters.

Rai and Das (1975) recorded narrow sense heritability estimates and found to be high for plant height and seed index, and additive portion of genetic variance to be substantial for plant height and seed index, ascertaining further the possibility of selection for high genetic gain in these traits.

Rai (1976) observed high estimates of narrow sense heritability for days to flowering and maturity in parents, F_1 and F_2 generations of linseed.

Bhatnagar and Mehrotra (1979) studied heritability of iodine value in F_1 and F_2 generations in linseed crosses and observed that heritability value was high in both F_1 (59.8) and the F_2 (61.3) generations for the trait.

Singh (1979) observed lowest heritability for seed yield per plant and highest for plant height in linseed.

Kumar *et al.* (1980) analyzed 10 parental diallel in linseed and noted high heritability estimates for days to flowering and moderate for days to maturity.

Kumar and Chauhan (1982) observed high narrow sense heritability for plant height and 1000- seed weight while, moderate for seeds per capsule, tillers per plant and branches per plant. They further reported substantial genetic gain for capsules per plant, plant height and branches per plant, suggesting that these characters are useful for selection if considered simultaneously.

Srivas and Singh (1984) reported high estimates of heritability for days to maturity, plant height, number of primary and secondary branches per plant. Genetic gain was highest for plant height, secondary branches and capsules per plant.

Ingale (1985) studied ten characters in 93 strains of linseed and reported that all characters viz. seed yield, capsules per plant, tillers per plant, 1000-seed weight, days to flowering and maturity, capsule length and seeds per capsule, showed moderate heritability estimates. He also reported high genetic advance for seed yield and 1000- seed weight.

Rai et al. (1985) analyzed the seeds for oil , protein, fibre, moisture, fatty acids profile, iodine value and saponification value of oil and reported that broad sense heritability was high for all the characters. Genetic advance was the higher for stearic acid content of the oil.

Rao and Singh (1985) studied F_1 and F_2 generations of inter-variety crosses of linseed and reported that heritability and expected genetic advances were moderate to high for yield components namely, primary branches, secondary branches, number of capsules and yield per plant.

Satpathi et al. (1987) noted high heritability estimates and genetic advance for number of branches per plant, capsules per plant and seed yield per plant indicating additive gene effects.

Singh and Dikshit (1988) reported high heritability in plant height, capsules per plant and harvest index in F_1, indicating that these characters can be improved by selections.

Jagdev (1990) observed high variability for harvest index (24.5-46.1) but low for economic yield (1.07-2.93). The estimates of heritability and genetic advance were high for both harvest index and economic yield.

Rai et al. (1990) reported high heritability with medium to low genetic advance for oil content, protein content and iodine values from a study of 35 linseed genotypes.

Niu et al. (1991) observed that broad sense heritability was higher than narrow sense. Relatively high

narrow sense heritability was reported for flowering date, 1000 - seed weight and plant height.

Mishra (1992) reported high estimates of heritability (narrow sense) for days to maturity in both the generations. Moderate for days to germination, seeds per capsule in F_1, plant height and oil content in F_2 and for capsules per plant and 100 seed weight in both F_1 and F_2 generations. Days to germination, seeds per capsules in F_2 and yield per plant in F_1 and F_2 displayed low heritability.

Khorgade and Pillai (1994) studied 10 characters related to yield in 28 F_1 hybrids involving eight parents of linseed and reported highest heritability and variability for capsule number per plant.

Jagdev (1995) conducted an experiment on 20 genotypes of linseed and found moderate heritability and genetic advance for economic yield, biological yield and harvest index emphasizing selection in respect of these attributes.

Popescu et al. (1995) reported narrow sense heritability estimate as fairly high for flowering duration and was not correlated with seed yield in flax.

Mirza et al. (1996) recorded heritability along with genetic advance as percentage of mean as high for plant height, harvest index, seed yield per plant and capsules per plant.

Foster et al. (1997) studied 18 linseed and 10 flax varieties, linseed varieties showed more heritable variation in seed and fibre traits than flax. In general, linseed x linseed and linseed x flax crosses would contribute better source material for

breeding high yielding dual-purpose cultivars compound to flax x flax crosses, especially when seed is the primary commercial product.

Foster et al. (1998) estimated heritability from low (0.20) for number of branches to high (0.71) for height at flowering time. Seed weight and straw weight showed moderate heritability while flowering time and the various height traits were more highly heritable.

Mahto and Mahto (1998) studied 19 genotypes of linseed grown under rainfed conditions during the winter season of 1990-91 and 1994-95. The highest heritability was given by days to maturity.

Popescu et. al. (1998) observed in a set of 61 hybrids, that narrow sense heritability coefficients confirmed the uniform transmission of oil content and plant height. Character number of capsules/m^2, seed yield and oil yield showed sufficient heritability coefficients (above 0.5) except 1000 seed weight.

Yadav et al. (1998) estimated high heritability coupled with high genetic advance was observed for 1000-seed weight. Character 1000 seed weight could be emphasized for selection breeding because predominance of additive gene action. High heritability coupled with low genetic advance for oil content and iodine value were observed suggesting that the recombination breeding programme will be more effective.

Mishra and Yadav (1999) observed high heritability coupled with high genetic advance for seeds/capsules, days to maturity and capsules/plant, indicating the importance of additive gene action for these traits.

Tiwari (1999) recorded high heritability estimates for days to flowering, plant height, technical plant height, days to maturity, seeds per capsule, 1000-seed weight, palmitic acid, stearic acid, oleic acid, linolenic acid and linolenic acid in both the generations. The characters viz. branches per plant in both the generations and tillers per plant in F_1 generation and oil content in F_2 generation exhibited comparatively moderate values of heritability whereas, it was low for capsules per plant, yield per plant in both the generations, tillers per plant in F_2 and oil content in F_1 generation only.

Yadav and Gupta (1999) estimated high heritability for the characters 1000 seed weight, plant height, days to maturity, days to 50% flowering and oil content in percent. Characters, 1000 seed weight also indicated high genetic gain followed by harvest index and plant height manifesting that these characters should be highly emphasized for selection purposes.

Rai *et al.* (2000) observed high heritability for linoleic acid, technical plant height, harvest index, oleic acid, fibre content, days to 50 per cent flowering, 1000-seed weight, days to maturity, plant height, linolenic acid, iodine value and oil content; moderate for protein content, number of seeds per capsule, palmetic acid, stearic acid and seed yield per plant and low for remaining traits. High genetic advance were noted for six traits moderate for nine and low for five traits out of twenty traits studied.

Genotype × Environment Interaction Stability:

A phenotype is the product of an interplay of a genotype and the environment. A particular genotype does not reflect the same phenotypic expression under different environments and different genotypes respond differently to the same environment. The variation arising out from the lack of correspondence between the genetic and non-genetic effects is known as genotype- environment interaction.

Environment is the sum total of physical, chemical and biological factors. Comstock and Moll (1963) classified the environments into two groups (i) Micro-environment and (ii) Macro-environment. Micro-environment is the environment of a single organism, as opposed to that of another organism growing at the same time and at almost the same place. Macro-environment which is associated with a general location and period of time and is a collection of macro-environments.

Allard and Bradshaw (1964) classified environments into predictable and unpredictable types. The predictable (controlled) environment included the permanent features of environment such as, climate, soil type, day length and agronomic practices followed. The unpredictable or uncontrolled environment means weather fluctuation such as, difference between seasons in terms of amount and distribution of rainfall, solar radiation and the prevailing temperatures. For the uncontrollable variables, a low level of interaction would be desirable so as to have maximum uniformity of performance over a number of seasons. Contraily, For the controllable variables mostly agronomic practices, a high level of interaction will be required for maximum increase in performance of a genotype.

Quantative characters are largely influenced by the environment. The genotype-environment interaction gives an idea of the magnitude of biasness in the estimation of genetic parameters. This bias is accounted for by growing the breeding material over a number of environments of breeder's interest.

Plant breeder is interested in the stability of productivity of the characters of economic importance such as grain yield and quality. The desirable genotypes should express less interaction of genotype and environment for the characters which are important from agricultural point of view. Phenotypic stability is attributed as the ability of an individual or population to produce narrow range of phenotypes in different environments. A variety could have stability of performance (Allard and Bradshaw, 1964) (i) by individual buffering, where each number of population is well adapted to wide range of environments and (ii) by population buffering, where each member of genotypes is adapted to some what different range of environments. Both individual and population buffering can be measured as genotype-environment interaction.

A dynamic approach to the interpretation of varietal adoptation to varying environments was developed by Finlay and Wilkinson (1963). They used the stability parameters namely, (i) mean performance over all the environments, (ii) linear regression coefficient (b_i) for the performance of individual variety passed on environmental index (mean yield over all the varieties in each environment). The unity and zero regression coefficient indicated average and absolute stability, respectively. They proposed that a well adapted genotype should have high mean

performance and average stability and ideal variety was one with maximum yield potential and maximum phenotypic stability.

Mather (1943) proposed a polygenic system narrating stability which may be a material effect and level of stability appearing to depend on genic balance. Lewis (1954) defined phenotypic stability as the ability of an individual to produce a certain narrow range of phenotypes in different environments. He proposed that no-genetic variability of individuals within a single controlled environment due to "intangible environmental effect produced by developmental accidents" may be expressed for F_1 as relative variability. He further noted that there is a positive linear relationship between F_1 relative variability and the degree of dominance.

Mather and Jones (1958) demonstrated that how the interaction between genotype × environment influences variances and co-variances used for measuring variation in biometrical genetic models. Plaisted and Peterson (1959) advocated a method to estimate the variance components of variety × location interactions. A combined analysis of variance over all the locations was computed for all possible combinations of pairs of varieties. The variety with smallest mean value of interaction variance (Variety × Location) was considered to be the most stable one. This technique was most cumbersome when the number of varieties are increased and did not provide partitioning of the interaction items.

Eberhart and Russell (1966) improved the regression technique as suggested by Finlay and Wilkinson (1963) by adding another stability parameter (s^2_{di} deviation from regression) to describe the performance of a genotype over an

array of environments. They further advocated that regression of each cultivar on the basis of environmental index and function of the squared deviation from this regression would provide usefull estimates of stability. They defined stable variety as one with unit regression coefficient $b_i = 1$ and having deviation not significantly different from zero ($s^2_{di} = 0$).

This enable repartitioning of the genotype × environment interaction of each variety and provided an useful estimate of stability. The genotypes contributing least to the G × E interaction, were the most stable.

Bucio Alanis (1966) developed a model to investigate the genotype × environment interaction in more detail and observed a linear relation of G × E interaction component of generation means to the environmental effects.

Perkins and Jinks (1980) abridged the gap between two approaches, i.e., statistical approach (Yates and Cochran 1938; Finlay and Wilkinson, 1963: Eberhart and Russell, 1966) and the approach based on contributions of genetic, environmental and their interaction with generations mean and variance (Mather and Jones, 1958: Jinks and Stevens 1959: Bucio Alanis 1966: and Alanis and Hill, 1966) and developed a model to measure the stability of genotypes. They expressed the expectations of statistical analysis in terms of gene, environmental interaction and genotype × environmental interactions. They further extended the analysis to cover many inbred lines and crosses among them and concluded that while a significant proportion of the G × E interaction component was linear function of the environmental components, there was still significant remainder which was not linear. Perkins and Jinks

(1968b) examined the non-linear component of the interaction by grouping varieties into homogenous groups on the basis of deviation from lineâr regression and reported a significant and marked reduction in the remainder component of the interaction as a result of grouping of varieties. They noted positive correlations between the regression remainder mean sum of squares values of the lines before and after grouping.

Freeman and Perkins (1971) argued that according to the models proposed by Eberhart and Russell (1966) and Perkins and Jinks (1968b), the performance of a genotype in the given environment is regressed over the environmental index. Which does not provide independent estimation of the two parameters. Hence, they suggested an independent estimate of environmental index by dividing replications into two groups, (i) group for measuring the average performance of genotypes in various environments and the (ii) group for estimating the environmental index and by using one or more genotypes as checks to assess the environmental index on the basis of performance. They further, partitioned the analysis of variance into components representing regression on a general measure of the environment, independent of the genotypes under study and deviations from regression.

Paroda and Hayes (1971) observed that genotype-environment interactions were operative in both the parents and F_1 generation. A significant portion of these interactions exhibited (i) linear function of the environment, means while some of them were non-linear, (ii) both linear and non-linear components of the G × E interaction were under the control of different systems and (iii) the interaction between additive

component and environments was greater than that of the dominance component in different environments.

Hardwick and Weed (1972) used multiple regression of performance non the levels of environmental variables considered the deviation from regression. They found that the slopes of regression on the environmental means could be expressed in terms of the coefficient of regression on environmental variable.

Chaudhary and Paroda (1979) studied stability in relation to homogeneous and heterogeneous populations and noted that homogeneous population were less buffered than the heterogeneous populations. Heterozygous-heterogenous (F_2 and F_3) and homozygous-heterogeneous (mixtures) populations representing high genetic variability expressed relatively more stability over homozygous-homogeneous (parental) and heterozygous-homogeneous (F_1) populations.

Galkin and Sorochinskaya (1986) concluded that the effect of selection can be predicted satisfactorily on the basis of heritability for these traits only which had a high degree of genetic stability.

Khatyleva et al. (1987) studied the variation in the quantitative characters of 57 flax varieties and reported that genotype- environment interaction affected all the characters. They also studied high phenotypic variation for seed production.

Popescu (1991) worked out estimates of phenotypic stability in five varieties and 19 inbred lines Romania and one Hungarian variety Szegedi 62 in environments in 1990 using three non-parametric criteria recommended by M. Huehn. He

founded the superiority of the criteria used to the classical methods in assessing stability by various ways. He could not found significant differences in phenotypic stability for seed production and oil content in 25 different form.

Mishra et al. (1992) studied genotype and environment interaction in eight Linum usitatissimum varieties grown at five different locations, which was significant. Genotypes RLC-1 and RLC-4 were most stable genotypes across the environments.

Mishra and Rai (1993) calculated genotype × environment interaction and stability of 10 genotypes and their 45 F_1 hybrids in eight traits including seed yield and quality characters in four environments and reported stability in genotype T-397 for seed yield per plant and oil content, R 552 for protein content, R 17 for palmitic acid content .

Mehto et al. (1995) studied genotype and environment interaction which was significant for 26 genotypes grown during 1988-89, 1989-90 and 1990-91. Analysis of variance showed presence of significant variability among the genotypes for all the characters. Of the 26 genotypes, eleven had above average stability and seven were of high yields.

Mehto (1995) conducted studies on genotypic × environment interaction and stability analysis of 19 genotypes in the years 1989-90, 90-91, 91-92. He furnished that the genotype × environment interaction was significant for number of branches per plant and highly significant for plant height, number of seeds per capsule and number of capsules per plant.

BAUL 135, LCK 6857 and Sweta were fund to be the most stable genotypes.

Mahto and Singh (1996) conducted stability analysis of 20 strain during 1989-91 grown over 4 environments. Stability for individual strains was determined on the basis of 2 stability parameters: regression coefficient (bi) and deviation from regression (s^2_{di}). A further 7 strains were selected with high seed yield per plant (higher than grand mean over environment) and stability for seed yield and for other yield contributing characters.

Payasi and Bose (1999) studied stability parameters for yield and its components in 80 genotypes under 8 micro-agroclimatic conditions. RLC4 had the highest yield followed by SPS49-2, Jawahar-23, LMH81 and ECZ-2583 and therefore; recommended for commercial cultivation under better management practices. R 1156, R 552, SPS 48-5 and LCK8323 showed wider adaptability for seed yield per plant and seed yield per hact., so they may be successfully grown in all type of environments. The highly stable genotypes T 397,EC 41484, RC23-1 and BAU95 are only suitable for rainfed farming system. RLC 41484,RLC 4 and IL 5164 were highly responsive for capsules/ plant, while LHCK5 and EC 15888 were responsive for seeds/ capsule.

Yadav *et al.* (2000) Studied stability in three locations for 13 metric and quality characters.T-397, Garima and ES –44 showed stability for seed per plant. Stability in yield was found to be associated with stability in yield components such as early growth vigour, days to 50% flowering, tillers per plant, branches per plant, days to maturity and seeds per capsule.

Chapter-III

MATERIAL AND METHOD

MATERIAL AND METHODS

Materials:

The foundation material of present investigation comprising ~~of~~ 10 parents of linseed (**Linum usitatissimum L.**) including Neelum, Shubhra, Sweta,LMH-62,DPL-21,J-23,RLC-6, Garima, KL-43 and LCK-88062 was taken from genetic stock maintained at All India Co-ordinated Research Project Centre, Mauranipur. The distinguishing features of these parents along-with their parentage are given in table-1.

Methods:

(a) Experimental plan:

A set of 45 F_1 hybrids with no reciprocals were made during Rabi 1996-97 by using diallel cross techniques. In the year 1997-98 F_2 generation was raised and half of F_1 seed was kept reserved to conduct the trial.

Experiment consisting of 10 parents, each 45 F_1s and F_2s were grown during Rabi 1998-99 in a Randomized Complete Block Design with three replications at three different locations viz; Rath, Jabalpur and Kanpur. The sowing of the experiment was done on November 5, 1998 at Dairy Farm- B.N.P.G. college, Rath; November 6, 1998 at Crop Research Farm- Oil Seeds, Kanpur and November 8, 1998 at crop Research farm J.N.K.V.V, Jabalpur. The plot for non-segregating generations (parents and F_1s) and for segregating generations (F_2s) represented single row. Non-experimental rows were also planted to reduce the border effects. Rows were planted in 3m. of length spaced at 45 cm.

apart. Within the rows, seeds were sown at 10 cm apart in hill at each location. All the experiments were given equal dose of fertilizer @ 90kg N_2: 30 Kg P_2O_5: 30 Kg K_2O per hectare at each location to raise a very good crop.

OBSERVATIONS RECORDED:

Data were recorded on 10 randomly selected plants in parents and F_1s and 20 in F_2s for following characters :

1. Days to 50 per cent flowering :

The number of days ~~for~~ 50 percent of flowering was counted from the date of sowing in each parents/cross in each replication.

2. Days to maturity :

Total number of days ~~for~~ physiological maturity was counted from the date of sowing.

3. Plant height :

It was measured in centimeters from the ground level to the terminal shoot of the plant after maturity with the help of meter scale.

4. Technical plant height (cm.):

It was measured in cm. from the base to the point from where branching starts.

5. Number of tillers per plant :

Total number of tillers bearing capsules were counted to the base of the plant when it was to be matured.

6. Number of branches per plant :

Total number of productive branches were counted before harvesting in sampled plants at the time of maturity.

7. Number of capsules per plant :

Total number of capsules bearing seeds were counted in selected plants at the time of maturity and mean number were calculated as per plant.

8. Number of seeds per capsule :

Seeds of ten randomly selected capsules were counted and average number were estimated.

9. 1000-seed weight :

Exact 1000-random seeds of each parents and crosses were counted from each replication and weighed in gram upto two decimal points with the help of electronic balance.

10. Harvest Index :

The ratio of economic yield to the biological yield gives harvest index and the value is expressed in percentage (Donald, 1962), seed yield was divided by biological yield of plants and after multiplying by 100 it was measured as:

$$HI\ (\%) = \frac{\text{Seed yield (economical yield)}}{\text{Biological yield}} \times 100$$

11. Fibre yield per plant (g.) :

Single plant was harvested from ground level, threshed and the stalk was cut from first branching. Bundles were prepared by tieing 10 plants together and placed in retting

tank filled with water and left for 3 days. Bundles were washed 8-10 times and than sun dried. Each plant from the bundle was separated and beaten by Mugari on plain surface. Wooden part of the stalk was discarded and the fibre was separated.

12. Oil content % :

It was measured in percent with the help of Nuclear Magnetic Resonance (NMR) instrument as per methods suggested by Tiwari *et al.* (1974).

13. Seed yield per plant :

The seeds of each selected plants were bulked and weighed with the help of electronic balance in gram upto two decimal points then average weight were calculated.

Statistical and Biometrical analysis :

The experimental data were computed by taking mean of each treatment in all the three replications location-wise and finally it was subjected to the following statistical and biometrical analysis :

Analysis of variance :

The analysis of variance for the experiment was based on the model:

$$P_{ijk} = u + v_{ij} + r_k + e_{ijk} \text{ (ij =1, ... t; k=1,...,r)i\#j.}$$

Where,

P_{ijk} = the phenotypes ijkth observation

u = the population mean

v_{ij} = the effect of ith variety on jth progeny

r_k = the effect of kth replication

e_{ijk} = the error for ^{e}ijkth observations

Based on present model, the data obtained from 10 parents, diallel mating were first of all subjected location – wise for analysis to randomized complete block design analysis on the mean basis. The skeleton ANOVA is given as under:

Skeleton of ANOVA for parents and F_1s ?

Source of variation	**d.f.**	**M.S.**	**F test**
Replications	(r-1)	Mr	Mr/Me_2 for r-1,(r-1) (t-1) ~~of f~~
Treatments	(t-1)	Mt	Mt/Me_2 for t-1, (r-1) (t-1) ~~of f~~
Parents (P)	(p-1)	Mp	Mp/Me_2 for p-1, (r-1) (t-1) ~~of f~~
F_1s	(F_1-1)	Mf_1	MF_1/Me_2 for F_1-1,(r-1) (t-1) d.f.
Parents vs. F_1s	1	Mh	Mh/Me_2 for 1, (r-1) (t-1) d.f.
Error	(r-1) (t-1)	Me_2	

Skeleton of ANOVA for parents and F_2s ?

Source of variation	**d.f.**	**M.S.**	**'F' test**
Replications	(r-1)	Mr	Mr/Me_2 ~~Fot-~~1, (r-1) (t-1) d.f.
Parents	(p-1)	Mp	Mp/Me_2 for p-1, (r-1) (t-1) d.f.
F_2s	(F_2-1)	Mt_2	Mf_2/Me_2 for F_2-1, (r-1) (t-1) d.f.
Parents Vs F_2	1	Mh	Mh/Me_2 for 1, (r-1) (t-1) d.f.
Error	(r-1) (t-1)	Me_2	

Skeleton of pooled ANOVA :

Source of Variation	d.f.	S.S.	M.S.
Genotypes	(v-1)	$(1/nr)\ \Sigma\ y2_{i....} -(y^2/vrn)$	M_1
Locations	(n-1)	$(1\text{-}vr)\ \Sigma\ y2_{j..} \text{-}\ (y^2/vrn)$	M_2
Replication within location	n(n-1)	$\Sigma\ [(1/v)\ \Sigma\ (y2j.\ k\text{-}yj/vr)]$	M_3
Genotypes × locations	(v-1)	$(1/r)\Sigma\ \Sigma\ y2_{ijk}\text{-}y2..../vrn$	M_4
Error	n(n-1)(v-1)	Pooledover environments	M_5

Where,

v, n and r stand for the number of genotypes, environments and replications, respectively.

Diallel Analysis :

Testing the validity of the hypothesis :

To test the validity of the hypothesis i.e., the assumptions regarding the diallel analysis as proposed by Hayman (1954), like (i) diploid segregation (ii) no maternal effect (iii) no linkage (iv) no multiple allelism (v) independent action of non- allelic genes and (vi) homozygosity of parents, the t^2 test was applied as suggested by Hayman (1954 a) :

$$t^2 = (n\text{-}2)/4 \frac{\text{var } (Vr\text{-var } Wr)^2}{(\text{Var } Vr \text{ x Var } Wr) - (\text{Cov}^2\ Vr, Wr)}$$

which is an F test with 4 and (n-2) degree of freedom.

A significant value of t^2 would indicate the non-uniformity of Wr, Vr, and thus, invalidates the hypothesis

postulated. The failure of hypothesis is also indicated by non-significant regression co-efficient.

$$b = \frac{\text{Cov (Wr,Vr)}}{\text{Var Vr}}$$

$$\text{Where, Cov (Wr,Vr)} = \frac{\{\Sigma = \text{Vr Wr} - \Sigma \text{ Vr } \Sigma \text{ Wr}\}/n-1}{N}$$

$$\text{and Var Vr} = \{\Sigma Vr^2 - (\Sigma Vr)^2/n\}/n-1$$

The standard error of regression coefficient (b) was calculated as :

$$\text{SE (b)} = \frac{\text{Var Wr-b Cov Wr Vr}}{\text{Var Vr (n-2)}^{\,0.5}}$$

Where, n = number of parents.

Now the significance of difference of 'b' from zero and unity was tested by using 't' value of b-o/ SE (b) and (1-b)/SE (b) with (n-2) degree of freedom.

1. Variance components analysis :

The components of variance in diallel cross were computed by the equation as given by Hayman (1954 a).

Expectation for F_1 diallel are :

$$Vp = \hat{D} + \hat{E}$$

$$Vr = (1/4)\hat{D} + (1/4)\hat{H}_1 - (1/4)\hat{F} - \{(n+1)/2n\}\hat{E}$$

$$Wr = (1/2)\hat{D} - (1/4)\hat{F} + (1/2\,{}^{n})\hat{E}$$

$$Vm = (1/4)\hat{D} + (1/4)\hat{H}_1 - (1/4)\hat{H}_2 - (1/4)\hat{F} + (1/2\,n)\hat{E}$$

Expectations for F_2 diallel are -

Jinks (1956) and Hayman (1958) gave the expections for F_2 diallel crosses. The expected statistics for F_2 generation are the same as that of F_1, except that the contributing of h^2; is halved by one generation of inbreeding. Hence, the coefficient of H_1 and H_2 are half of those of F_1 statistics, while the coefficient of F is halved being second and first degree statistics of h^2, receptively (Jinks, 1956; Hayman, 1958; Mather and Jinks 1971). These expectations are as follows :

$$Vp = \hat{D} + \hat{E}$$

$$Vr = (1/4)\,\hat{D} + (1/16)\,\hat{H}_1 - (1/8)\,\hat{F} + \{(n+1)/2n\}\hat{E}$$

$$Wr = (1/2)\,\hat{D} - (1/8)\,\hat{F} + (1/n)\,\hat{E}$$

$$Vm = (1/4)\,\hat{D} + (1/16)\,\hat{H}_1 - (1/16)\,\hat{H}_2 - (1/8)\,\hat{F} + (1/2n)\hat{E}$$

Where,

$\hat{D}$ = components of variation due to additive effects of genes

$= V_0\,L_0 - E$

$\hat{H}_1$ = Components of variation due to dominance effects of genes

$= V_0\,L_0 - W_0\,L_0 - (3n-2)\,\hat{E}/n$

$\hat{H}_2 = \hat{H}_1\,\{1-(u-v)^2\} - 4\,Vi\,Li - 4\,V_oL_o - 2\hat{E}$

Where,

u = proportion of positive genes in the parents

v = proportion of negative genes in the parents

F = mean of Fr over arrays

Fr = $2\,(V_0L_0 - W_0L_{0i} + V_i\,L_i\,W_r - V_r) - 2\,(n-2)E/n$

$\hat{h}^2$ = dominance effect (as the algebraic sum over all loci in heterozygous phase in all crosses)

= $4\,(M_{Li} - M_{L0})^2 - 4\,(n-1)\,E\,/n^2$

$\hat{E}$ = the expected environmental component of variation

= (Error SS + Replication SS/d.f.)/number of replication

In order to estimate the accuracy of the components ($\hat{D}$, $\hat{F}$, $\hat{H}_1$, $\hat{H}_2$,$\hat{h}^2$ and $\hat{E}$) of variance, the term of main diagonal of the matrix given by Hayman (1954) with common multipliers s^2/n^5 was used.

Where,

S^2, = ½ Var, (wr-vr). The formula being :

$SE\,(\hat{D}) = \pm\{ S^2\,(n^5 + n^4\,)/n^5\,\}^{0.5}$

$SE\,(\hat{F}) = \pm\{ S^2\,(4n^5 + 20n^4 - 16n^3 + 16n^2)/n^5\}^{0.5}$

$SE\,(\hat{H}_1) = \pm\{S^2\,(n^5 + 41n^4 - 12n^3 + 4n^2)/n^5\}^{0.5}$

$SE(\hat{H}_2) = \pm\{S^2(36n^4)/n^5\}^{0.5}$

$$SE(\hat{h}^2) = \pm\{S^2(16n^4 + 16n^2 - 32n + 16)/n^5\}^{0.5}$$

$$SE(\hat{E}) = \pm\{S^2(n^4/n^5)\}^{0.5}$$

After testing the significance of the components of variation, the mean degree of dominance was calculated as $(\hat{H}_1/\hat{D})^{0.5}$ in F_1 and $\{0.25(\hat{H}_1/\hat{D})\}^{0.5}$ in F_2 generation. The proportion of genes with positive and negative effects were calculated as $\hat{H}_2/4\hat{H}_1$, the proportion of dominant and recessive genes in parents as $[(4\hat{D}\hat{H}_1)^{0.5} + \hat{F}]/[(4\hat{D}\hat{H}_1)^{0.05} - \hat{F}]$ in F_1 and $[0.25(4\hat{D}\hat{H}_1) + 0.05\hat{F}]/[0.25(4\hat{D}\hat{H}_1)^{0.5} - 0.5\hat{F}]$ in F_2 generation, the number of gene groups which control the character and exhibit dominance as $\hat{h}^2/\hat{H}_2$, and coefficient of correlation between the parental order of dominance (Wr + Vr) and parental measurement (Yr) as r.

Combining ability analysis :

The combining ability analysis was worked out by the procedure suggested by Griffing's (1956 b) Method 2, Model I. The mathematical model for combining ability analysis is assumed to be :

$$X_{ijkl} = u + g_i + g_j + S_{ij} + 1/bc\ e_{ijkl}$$

i,j = 1,2,3,...... n;

k = 1,2,3,.......b;

l = 1,2,3.......c;

Where , u = population mean

g_i = general combining ability (gca) of i^{th} parent.

g_j = gca of j^{th} parent.

S_{ij} = specific combining ability of the cross between i^{th} J^{th} parent such that $S_{ij} = S_{jl}$

E_{ijkl} = environmental effect associated with the ijk^{th} individual observation of i^{th} individual in k^{th} block with i^{th} as female parent and j^{th} as male parent.

The usual restrictions, such as $g_{ii} = 0$ and

$S_{ij} = s_{ji} = 0$, (for each i) are imposed.

The analysis of variance table for combining ability is as follows :

ANOVA for combining ability :

Source of variation	d.F.	S.S	M.S.	'F' test
GCA	n-1	Sg	Mg	Mg/Me,for n-1,m.d.F.
SCA	n(n-1)/2	Ss	Ms	Ms/Me,for n(n-1)/2,mdf
Error	m	Me	Me	

Where,

$S_g = 1/n+2 \{ \Sigma (x_i + x_{ii})^2 - (4/n)\, x^2.. \}$

$S_p = i^{\Sigma\Sigma}j\ x_{ij}^2 - 1/n+2\ \Sigma\ (x_1 + x_{ii})^2 + \{ 2/\ (n+1)\ (n+2) \}\ x^2..$

Mel = Me/r

Where,

r	=	number of replications
Me'	=	Error M.S. obtained from main ANOVA
S_g	=	sum of squares (S.S.) due to g.c.a.
Ss	=	sum of squares due to s.c.a.
n	=	number of parents.
x_i	=	total of the array involving i^{th} as a female
x..	=	grand total
x_{ii}	=	value of i^{th} parent of the array
x_{ij}	=	value of the cross, with i^{th} as a female parent and j^{th} as a male parent.

The component of variances were estimated (Singh, 1979) as under:

gca expected m.s. = $\hat{\sigma}^2 + 1/(n-1)\Sigma_i \hat{g}_i{}^2$ or σ^2 gca = (Mg-Me)/n+2

sca expected m.s. = $\hat{\sigma}^2 + 2/n(n-1)\ \hat{s}^2_{ij}$ or σ^2 sca = (Ms-Me) .

where,

Mg = Mss gca, Ms = Mss sca and Me = Mss error obtained from combining ability analysis and n = number of parents.

The general predictability ratio (GPR) was computed as :

GPR = $2\hat{\sigma}^2$ gca/$2\hat{\sigma}^2$ gca + $\hat{\sigma}^2$sca

Estimates of various effects:

The various effects were estimated as follows :

gca effect on i^{th} parent $= \hat{g}_i = 1/(n+2)\ \{(\Sigma x_i + x_{ii}) - (2/n)\ x...\}$

sca effect on ij^{th} cross $= \hat{s}_{ij} = x_{ij} - 1/(n+2)\ \{x_i - x_{ii}\ x_{ij} + x_{jj}) +$
$2x/(n+1)\ (n+2)\ x\ ...$

Where, $\hat{g}_i$ and $\hat{s}_{ij}$ are the estimates of the general and specific combining ability effects respectively, and n, x_i x_i x_{ii} . x.. and x_{ij} are the same as explained earlier, x_j = total of the arrays involving j^{th} parent as a male and x_{jj} = the value of j^{th} parent of the array

Estimation of standard errors:

$$SE(\hat{g}_i) = \{(n-1)\ \sigma^2 e/n\ (n+2)\}^{0.5}$$
$$SE(\hat{g}_{ij}) = \{(n^2+n+2)\ \sigma^2 e/\ (n+1)\ (n+2)\}^{0.5}$$
$$SE(\hat{s}_{ij}) = \{2\ (n-1)\ \sigma^2 e/(n+1)\ (n+2)\}^{0.5}$$
$$SE(\hat{g}_i - \hat{g}_j) = \{2\sigma^2 e/(n+2)\}^{0.5}$$
$$SE(\hat{s}_{ii} - \hat{s}_{ij}) = \{2(n-2)\ \sigma^2 e/(n+2)\}^{0.5}$$
$$SE(\hat{s}_{ij} - \hat{s}_{ik}) = \{2\ (n+1)\ \sigma^2 e/(n+2)\}^{0.5}$$
$$SE(\hat{s}_{ij} - \hat{s}_{kl}) = \{2n\ \sigma^2 e/(n+2)\}^{0.5}$$

Where,

$\sigma^2 e = Me'/r$, taken as error M.S. from the combining ability analysis.

Diallel Cross analysis for combining ability over environments.

Pooled analysis for combining ability for Method 2 was carried out on lines suggested by Singh (1973 & 1979). The mathematical model for estimating the parameter is based on:

$$x_{ijk} = \hat{u} + \hat{g}_i + \hat{g}_j + \hat{s}_{ij} + \hat{1}_k + (\hat{g}_1)_{ik} + (\hat{g}_i)_{jk} + (\hat{s}_1)_{ijk} + f_{ijk}$$

Least Square estimates of effects for g_i and S_{ij} were estimated as follows:

$$gi = [(x_i .. + x_{ii}. -(2/n)\ x....] / (n-2)\ 1$$

$$sij = (xij/1) - (x_i.. + x_{ii}. + x_j.. + x_{jj})/ (n+2)\ 1) + 2x ... (n+1)\ (n+2)\ 1$$

Sum of squares were worked out as under :

$$ss(g) = \frac{\underset{i}{s}\ (xi.. + ii.)2}{(n+2)\quad 1} - \frac{4x^2...}{n\ (n+2)\ 1}$$

$$ss(s) = \frac{\underset{i}{s}\ \underset{j}{s}\ x^2_{ij}}{1}\ \frac{\underset{i}{s}\ (xi.. + xii.)^2}{(n+2)\qquad 1} + \frac{(n+1)\ (n+2)\ 1\ \ 2\ x^2...}{}$$

$$ss(i) = \frac{2\underset{k}{s}x..k}{n\ (n+1)} - \frac{2X^2...}{n\ (n+1)\ 1}$$

$$ss\ (gi) = \frac{\underset{ki}{ss}\ (x_i.k. + x_{ijk})^2}{(n+2)} - \frac{4\underset{k}{s}\ x^2..\ k}{n\ (n+2)\ 1}$$

$$- \frac{\underset{i}{s}\ (x_{ii}.+ x_{ii}.)^2}{(n=2\quad 1)} + \frac{4x^2...}{n\ (n+2)\ 1}$$

$$ss\ (s_1) = \underset{ki}{ss}\ \underset{j}{s}\ x^2_{ijk} - \frac{\underset{ki}{ss}\ (x_{i,k} + x_{ijk})^2}{n+2} +$$

$$\frac{2\underset{k}{S}\ x^2..k}{(n+1)\ (n+2)} - \frac{\underset{i}{S}\ \underset{j}{S}\ x^2ij}{1} + \frac{\underset{i}{S}\ (x_i^{2} + x_{ii})^2}{(n+2)\ 1}$$

$$- \frac{2x^2...}{(n+1)\ (n+2)\ 1}$$

The skeleton of ANOVA along with expectations of mean squares for the random effects – Model II is given as below:

Source of Variation	**d.f.**	**S.S.**	**M.S.**	**Expectations of mean squares**
General combining ability (GCA)	(n-1)	ss(g)	Ag	$\sigma^2e+\sigma^2sl+(n+2)\,\sigma^2gl+$ $\sigma^2sl+10^2s+(n+2)\ 10^2s$
Specific combining ability (SCA)	n(n-1)/2	ss(s)	As	$\sigma^2e+\sigma^2sl+1\sigma^2s$
Environment (L)	(l-1)	ss(1)	A1	$\sigma^2e+\sigma^2sl^2(n+1)\,\sigma^2gl+$ $[n\,(n+1]\,/2]\,\sigma^21$
GCA × L	(n-1)	ss(gi)	Agl	$\sigma^2e+\sigma^2sl+(n+2)\sigma^2gl$
SCA × L	n(n-1) (l-1)/2	ss(s_1)	Asl	$\sigma^2e+\sigma^2sl$
Error	1 (b-1)	m	Ae	σ^2e

$$E\,(A_1) = \sigma^2e+[_{1s}]\,\sigma^2sl+[(_{lg})]\,\sigma^2{}_{gl}+\,[(_{11})\,\sigma^2{}_1]$$

$$E(A_{gl}) = \sigma^2e+(gs)\,\sigma^2sl+[gg]\,\sigma^2g\,_1$$

$$E(A_{sl}) = \sigma^2e+[ss]\,\sigma^2{}_{sl}$$

$$S(A_e) = \sigma^2e$$

Where, $[(_1s)]$, $[(_1g)]$ and $[(_{11})]$ are the coefficients of $\sigma^2{}_{sl}$'$\sigma^2{}_{gl}$ and σ^2e in E (A_1).

Values of (xa) = gs = $_1$, gg = n+$_2$, ss = $_1$

Values of (la) = $_1$s=1,lg= 2 (n+1), 11 = n (n+1)/2

The estimates of σ^2_x could be expressed as linear functions of AY' [(xa)] and [(la)]. The estimate of $\sigma^2 x$ could however, be given in simple form for method 2.

The estimates were,

σ^2_g = $(A_{sl} - A_{gl} - A_s + A_g) / [gg] 1$

σ^2_s = $(A_s - A_{sl}) / [ss] \ 1$

σ^2_l = $[(w-t)] A_e - (w-q) \ A_{sl} - qa_{gl} + tA_l] / (11) t$

σ^2_{gl} = $(A_{gl} - A_{sl}) / [gg]$

σ^2_{sl} = $(A_{sl} - A_e) / [ss]$

σ^2_e = A_e

Where,

W = [1s] [gg]; t = [ss] [gg]; q = [ss] [1g]

Precedure for testing σ^2_x = 0

The Variances were calculated as follows :

Var (g_i) = $[(n-1) / n (n+2) \ 1] \sigma^2$

Var $(g_i - g_j)$ = $[2/(n+2) 1] \sigma^2 \cdots (i = j)$

Var (s_{ij}) = $[(n^2+n+2) / (n+1)(n+2) \ 1] \sigma^2 \ldots (i = j)$

Var $(s_{ij} - s_{ik})$ = $[2(n+1) / (n+2) \ 1] \sigma^2 \ldots (i = j)j,k;(j = k)$

Expectations of mean squares in terms of coefficients of variance components in the expectations of mean squares for single environment:

The procedure of estimates could be simplified by using the expectations of mean squares for a single environment. We could express the expectations of mean squares as:

$$E(B_g) = \sigma^2 + [gs] \sigma^2_s + [gg] \sigma^2_g$$

$$E(B_s) = \sigma^2 + [ss]\,\sigma^2_s$$

$$E(B_r) = \sigma^2 + [rr]\,\sigma^2_r$$

Where, B_x is the observed mean square due to x and xa, the coefficient of σ^2 in the expectation of B_x taking into account the appropriate experimental method under consideration :

It could not be shown that the expectations of the mean squares for the case of 1 environment could be expressed in terms of (xa) as :

$$E(A_g) = \sigma^2 + [gs]\,\sigma^2_{sl} + [gg]\,\sigma^2_{gl} + [gs]\,\sigma^2_s + [gg]\,1\,\sigma^2_g$$

$$E(A_s) = \sigma^2 + [ss]\,\sigma^2_{sl} + [(ss)]\,1.\,\sigma^2_s$$

The following F-values were calculated as,

(i) To test $\sigma^2_g = 0$

$$F(p-1),\ f_g = (A_g/A_g^*)$$

Where,

$$A^*g = \frac{(A_{gl} = A_{sl} + A_s)^2}{df(s)\,A^2{}_{gl} + (p-1)\,A^2{}_{sl} + (p-1)\,(1-1)\,As}$$

(ii) To test $\sigma^2_s = 0$

$$F\,[df(s),\ (1-1)df\,(s)]As/Asl$$

(iii) To test $\sigma^2_1 = 0$

$$F(1-1),\ f_1 = (A_1/A_1^*)$$

where,

$$A_1^* = (t-w)\,A_e - (q-w)\,A_{sl} + {}^{qa}{}_{gl}/t$$

$$f_1 = \frac{[(t-w)Ae-(q-w)A_{sl}+qa_{sl}+qa_{gl}]^2\,(v-1)(b-1)(p-1)\,(1-1)\,df\,(s)}{(p-1)\,(1-1)\,df\,(s)\,(t-w)^2A_e+1(v-1)(b-1)(p-1)(q-w)^2\,A_{sl}+df\,(s)q^2\,A_{gl}}$$

(iv) To test $\sigma^2_{gl} = 0$

$F[(p-1)(1-1);df(s)(1-1) = A_{gl} / A_{sl}$

(v) To test $\sigma^2_{sl} = 0$

$F[df(s)(1-1), i(v-i)(b-i) = A_{sl} / A_e$

ESTIMATION OF HETEROSIS AND INBREEDING DEPRESSION

Heterosis:

The magnitude of heterosis was estimated with the help of following formula:

$$\text{Heterosis (\%) over S.P.} = \frac{\bar{F}_1 - \bar{SP}}{\bar{SP}} \times 100$$

$$\text{Heterosis\% over M.P.} = \frac{\bar{F}1 - \bar{M}.P.}{\bar{M}.P.} \times 100$$

Where,

$\bar{F}_1$ = mean of the F_1

$\bar{SP}$ = mean of the superior parent

$\bar{M}.P.$ = Mean of the mid parent

Test of significant:

Significance of heterosis over economic parents was tested as:

SE = $(2Me2/r)^{0.5}$

Where,

Me_2 = Error variance obtained from parents and F_1 combination

r = Number of replications

CD = SE X 't' ('t'value at 5% and 1%)

Inbreeding Depression:

The coefficient of inbreeding depression was calculated by the following formula:

$$\text{Inbreeding depression (\%)} = \frac{\bar{F}_1 - \bar{F}_2}{\bar{F}_1} \times 100$$

Where, F_1 = mean of F_1 generation

F_2 = mean of F_2 generation

Test of significance:

The significance of estimate was tested as:

SE (Inbreeding depression) = $(2Me3/r)^{0.5}$

Where,

Me_3 = Error variance obtained from F_1s + F_2s combination

r = number of replications.

Stability Analysis :

The statistical technique proposed by Eberhart and Russell (1966) was utilized to estimate stability

parameters and genotype x environment interaction for different genotypes with respect to different characters.

Eberhart and Russell (1966) suggested three parameters to measure stability of cultivars. These are (i) mean (x), (ii) regression of individual mean performance of environmental index (b_i) and (iii) deviation from regression ($s^2{}_{di}$). These parameters are defined in the following model:

Where,

Y_{ij} = $u_{ij} + b_i I_j + \sigma_{ij}$

Y_{ij} = mean performance of i^{th} genotypes in j^{th} environment (i = 1, 2, 3-----v; j = 1, 2, 3----n)

v = number of genotypes

n = number of environments

u = mean performance of i^{th} genotypes over all the environment

b^i = regression coefficient of i^{th} individual mean performance on environmental index, I_j

^Ij = j_{th} environmental index, and

σ_{ij} = deviation from regression of the k^{th} genotype at j^{th} environment,

The environmental index for j^{th} environment, i=j is obtained as:

$$I_j = (\sum_{i=j} Y_{ij}/v) - \sum_{i=j} \sum_{j=i} Y_{ij}/v.n$$

where,

$$\sum_{j=1}^{v} I_j = 0$$

The first stability parameter regression coefficient (b_i) was estimated using following formula :

$$bi = [(\sum_{j=1}^{n} Y_{ij} I_j)/(\sum_{j=1}^{n} I^2_j)]$$

The second stability parameter (s^2_{di}) was estimated using the following formula :

$$s^2_{di} = (1/n-2) \sum_{j=i}^{n} \sigma^2_{ij} - \text{pooled error}$$

where,

$$\sum^{n} \sigma^2_{ij} = (\sum_{j=i}^{n} y^2_{ij} - y^2/n) - \frac{1}{n} \quad (\sum_{j=i} Y_{ij} I_j)^2$$

$$\sum_{j=i} i^2 j$$

The average of error mean squares over all the environments was taken as the estimate of pooled error.

The detail analysis of variance for the estimation of stability parameters and their tests of significance are given as follows:

Analysis of variance for estimation of stability parameters:

Source of variation	d.f.	s.s	M.S.
Total	(nv-1)	$\sum_{i=1}^{v} \sum_{j=1}^{n} Y^2_{ij}$ - CF = TSS	
Genotypes (G)	(v-1)	$1/n \sum_{i=1}^{n} Y^2_i$ - CF = GSS	MS_1
Environment (E)	n-1	$1/v \sum_{j=1} Y^2_i$ - CF = ESS	
E x G	(n-1) (v-1)	TSS - (GSS + ESS)	MS_2
E + (G x E)	v (n-1)	$\sum_{i=1}^{v} \sum_{j=1}^{n} Y^2_{ij} - 1/n \sum_{i=1}^{v} Y^2_i$	
E (Linear)	1	$1/v (\sum_{j=1}^{n} Y_j I_j)^2 / \sum_{j=1}^{v} I^2_j$	
G x E (Linear)	v-1	$\sum_{i=1}^{n} (\sum_{j=1}^{n} Y_{ij} I_j)^2 / \sum_{j=1}^{n} I^2_j$ - E (Linear)	MS_3
Pool deviation	v(n-2)	$\sum_{i=1}^{v} \sum_{j=1}^{v} \sigma^2_{ij}$	MS_4
Genotype	v (n-2)	$\sum_{i=1}^{n} Y_{ij}-(1/n)Y_1)^2 (\sum_{i=1}^{n} Y_{ij} I_j)^2 / \sum_{i=1}^{n} I^2_j$	
Genotype	v (n-2)	$\sum_{j=1}^{n} Y^2$ vi-(1/n) (Yv)2/-$(\sum_{j=1}^{n} Y_{vj} I_j)^2 / \sum_{j=1}^{n} I^2_j$	
Pooled error	n(r-1)	$\sum_{i=1}^{v} \sum_{j=1}^{v} \sigma^2_e$ = TSS - Grand SS (GxE)	MS_5

where,

v = number of genotypes

n = number of environment

σ^2_e = estimates of error mean square at each location (environment).

following test of significance were applied :

(i) The test of significance of differences among the mean performance of genotypes was calculated using the 'F' test.

$$F = MS_1/MS_4$$

(ii) The test of significance of difference among genotypes in respect of mean was calculated using the 't' test.

$$t = (u_i - u)/\ SE\ (x)$$

$$SE\ (x) = \sqrt{\frac{\text{Pooled deviation MS}}{\text{Number of environments-1}}}$$

u_i = mean performance of i^{th} genotype over all the environments, and

u = grand mean

(iii) Genotype x environment interaction was tested using the 'F' test : $F = MS_2/MS_4$

(iv) The genotypic differences among genotypes for their regression on the environmental index were tested using the 'F' test :

$$F = MS_3/MS_4$$

(v) The deviation of b_i value from unity was tested using the 't' test :

$$t = (b_i-1)/\ SE\ (b)\ \text{at v (n-2) d.f}$$

where,

$$SE\ (b) = \sqrt{\frac{\text{Pooled deviation MS}}{\sum_{j=1}^{n} I^2_j}}$$

(vi) Deviation from regression for each genotype was tested using the 'F' test :

$$F = 1/(n-1) \sum_{j=1}^{n} \sigma^2_{ij}/MS_5$$

Estimation of Selection Parameters :

(i) Heritability

(i) Heritability (narrow sense) in F_1 generation was calculated by the formula given by Crumpacker and Allard (1962) as given below:

$$h^2 = (1/4)D/(1/4)D + (1/4)\ H_1 - (1/4)F + E\}$$

Heritability, in F_2 generation was calculated according to the formula proposed by Varhalen and Murray (1969) as given below :

$$h^2 = (1/4)\, D / \{(1/4)\, D + (1/16)\, H_1 - (1/8)\, F + E\}$$

Where,

h^2 = estimate of heritability coefficient and $\hat{D}, \hat{H}, \hat{F}$, and $\hat{E}$ are the same as explained earlier.

Heritability (in per cent) = heritability coefficient x 100
Heritability estimates in percent over locations, based on different genetic values obtained from pooled analysis of combining ability (Singh, 1973 and 1979), was computed as under:

$$h^2\ (\%)\ \text{in}\ F_1 = [2\sigma^2_g / 2\sigma^2_g + \sigma^2_s + \sigma^2_{gl} + \sigma^2_{sl} + \sigma^2_e] \times 100$$

$$h^2\ (\%)\ \text{in}\ F_2 = [2\sigma^2_g / 2\sigma^2_g + \tfrac{1}{2}\sigma^2_s + \sigma^2_{gl} + \sigma^2_{sl} + \sigma^2_e) \times 100$$

Genetic advance:

The genetic advance was worked out by the formula proposed by Robinson et al. (1949) as-

$$GA = (k)\ (h^2)\ (\sigma^2 ph)$$

And genetic advance over mean of the character

$$GA\ (\%) = (GA/\bar{x}) \times 100$$

Where,

GA = estimate of genetic advance

k = selection differential at 5% selection intensity, i.e. 2.06

$\sigma^2 ph$ = phenotypic standard deviate

h^2 = estimate of heritability coefficient

$\bar{x}$ = mean of the character concerned

Chapter-IV

EXPERIMENTAL FINDINGS

EXPERIMENTAL FINDINGS

The present investigation entitled **"Studies on stability parameters and biometrical traits of yield and yield contributing characters in linseed (<u>Linum</u> <u>usitatissimum</u> L.)"** for 13 characters viz. days to 50% flowering, days to maturity, plant height (cm.), technical plant height (cm.), number of tillers per plant, number of branches per plant, number of capsules per plant, number of seeds per capsule, 1000 seed weight (g), oil content (%) and seed yield per plant (g).

The data obtained was subjected to the following statistical and biometrical analysis and the results were described accordingly under ~~herewith~~ following heads:

1- Analysis of variance of the experiment.

2- Mean and variability in parents, F_1s and F_2s.

3- Diallel analysis

    (i) Component analysis

    (ii) Combining ability analysis.

4- Heterosis and inbreeding depression

5- Stability analysis.

6- Heritability and genetic advance.

ANALYSIS OF VARIANCE:

The analysis of variance for all the 13 characters under study was computed for all the three locations (Rath, Jabalpur and Kanpur) separately for testing the significance of different combinations and fractions. The results are presented in table 2(a) and 2(b) which revealed the highly significant differences for all the characters except number of tillers per plant for all fractions in F_2 at Jabalpur and technical plant

height, number of branches per plant and harvest index in P vs F_2 at Kanpur.

The orthogonal breakup into different components revealed the significant differences for parents.

MEAN AND VARIABILITY IN PARENTS, F_1's & F_2's:

The mean and range of parents and their crosses as F_1 and F_2 for all the characters separately location wise and pooled over locations are given in table 4. Variation within the parents,F_1s and F_2s were significant for all the characters. However, its magnitude varied from character to character.

The variability among the parents was highest for plant height followed by technical plant height, number of capsules per plant, days to 50% flowering, days to maturity, number of branches per plant, harvest index, seed yield per plant, oil content, number of tillers per plant, fibre yield per plant, 1000 seed weight and number of seeds per capsule.

The variability among the F_1s was high for technical plant height, number of capsules per plant, plant height, number of branches per plant, days to 50% flowering, days to maturity, harvest index, seed yield per plant, number of tillers per plant, oil content, fibre yield per plant, 1000 seed weight and number of seeds per capsule.

The variability among the F_2s was high for technical plant height, plant height, number of capsules per plant, days to 50% flowering, days to maturity, number of branches per plant, harvest index, number of tillers per plant, seed yield per plant, oil content, fibre yield per plant, 1000 seed weight and number of seeds per capsule.

The mean of F_1 hybrids were more than their parental means for all the characters except days to 50% flowering which showed the same value.

The mean performance of F_2 progenies was less than F_1 s for all the characters except days to 50% flowering and days to maturity. The mean performance of F_2 progenies was higher than the parents for days to 50% flowering, days to maturity, technical plant height, number of branches per plant, number of capsules per plant. It was approximately equal to number of tillers per plant, number of seeds per capsule, 1000 seed weight, harvest index, fibre yield per plant, oil content and seed yield per plant. The mean of F_2s for plant height was less than parents mean value.

GENETIC COMPONENTS OF VARIANCE ANALYSIS:

The estimates of six parameters i.e., $\hat{D}$, $\hat{H}_1$, $\hat{H}_2$, $\hat{F}$, $\hat{H}_2$ and $\hat{E}$ alongwith their standard errors and related parameters for all the thirteen characters in both F_1 and F_2 generations at all the three locations were worked out. The findings are furnished in Table 5 and described as under –

The estimates of additive ($\hat{D}$) components were found to be significant at all the locations in both the generations for days to 50% flowering, plant height, number of capsules per plant, fibre yield per plant, oil content and seed yield per plant. Whereas, it was significant at all the locations for days to maturity except in F_2 at Jabalpur; for technical plant height except in F_1 generations at Jabalpur and Kanpur and for number of tillers per plant in F_2 generation for number of branches per plant except at Rath and Jabalpur in both the generations for number of seeds per capsule and 1000 seed

weight except at Kanpur in F_1 generation and for harvest index in F_2 generation.

The estimates of dominance components (H_1 and H_2) revealed highly significant and positive values for days to 50% flowering, number of capsules per plant, number of seeds per capsule, fibre yield per plant, oil content and seed yield per plant, at all the three locations and in both the generations. Similar magnitude of both the dominance components was observed for days to maturity except at Jabalpur in F_2; for plant height except in F_1 generation at Jabalpur for H_2 component. For technical plant height except in F_2 at Kanpur for H_1 component; for number of tillers per plant except in F_2 generation at Jabalpur and Kanpur for both the H_1 and H_2 components; for number of branches per plant and harvest index except at Kanpur in F_2 for both the components and for 1000 seed weight except in F_1 generation at Kanpur for H_1 and H_2 components. The value of additive component was higher for plant height in both the generations at all the three locations followed by technical plant height, days to 50% flowering and days to maturity on pooled basis. At Rath and Kanpur location highest estimate of dominance components (H_1 and H_2) was observed for technical plant height in F_1 generation and at Jabalpur location it was observed for plant height in F_2 generation .The higher magnitude of dominance components revealing the preponderance of non-additive gene action for controlling these traits.

The estimates of H_1 were higher than the value of H_2 for most of the characters indicating unequal distribution of positive and negative alleles in the population.

The $\hat{F}$ component revealed significant and desirable positive value for oil content at Rath in F_1 generation. For technical plant height and harvest index at Rath; for number of seeds per capsule and seed yield per plant at Jabalpur and for seed yield per plant at Kanpur these were positive and significant in second filial generation. At Kanpur $\hat{F}$ component revealed significant and positive value for fibre yield per plant in F_2 generation but negative value was observed in F_1 generation. Value of $\hat{F}$ indicated the excess of dominant and positive genes for controlling these traits whereas negative value indicated the presence of recessive genes than the dominant genes.

The positive and significant values of $\hat{h}^2$ was recorded in 49 cases out of 78 including F_1 and F_2 generations at all the three locations .The characters days to maturity, number of branches per plant, number of seeds per capsule, harvest index exhibited significant and positive value in both the generations and rest of the characters except days to 50% flowering showed significant and positive value in F_1 generation at Rath. The positive and significant value of $\hat{h}^2$ were recorded in both the generations for technical plant height, number of branches per plant, number of capsules per plant, 1000 seed weight, harvest index and seed yield per plant at Jabalpur whereas, significant value was observed for plant height in F_2 generation and for days to maturity, number of seeds per capsule, fibre yield per plant and oil content in F_1 generation at Jabalpur. The characters days to flowering, number of capsules per plant, fibre and seed yield per plant revealed significant $\hat{h}^2$ value for F_1 & F_2 generations at Kanpur. The positive and significant $\hat{h}^2$ value were shown by days to maturity and plant height in F_2 generation whereas significant value was observed for technical plant

height, number of tillers per plant, number of branches per plant, number of seeds per capsule, harvest index and oil content in F_1 generations at Kanpur. The positive and significant $\hat{h}^2$ value was observed for all the three locations for technical plant height, number of branches per plant, number of capsule per plant, number of seeds per capsule, harvest index, fibre yield per plant, oil content and seed yield per plant in F_1 generation. The character 1000 seed weight showed significant value of $\hat{h}^2$ in F_1 generation at Rath and Jabalpur locations whereas characters number of branches per plant and harvest index revealed significant $\hat{h}^2$ value in F_2 generation at Rath and Jabalpur. Days to maturity revealed significant $\hat{h}^2$ value at Rath and Kanpur and plant height, number of capsule per plant and seed yield per plant showed significant $\hat{h}^2$ value at Jabalpur and Kanpur. The significant and positive values of this estimate indicated the presence of more number of dominant genes in parents.

The values of $\hat{E}$ component were recorded significant in 26 out of 78 cases for all the three locations in both the generations. The characters, harvest index in both the generations at all the three locations; plant height at Rath and Jabalpur; number of capsule per plant at Rath and Kanpur in both the generations; number of tillers per plant at Jabalpur and Kanpur in F_2 generation; number of branches per plant in F_2 generation at Jabalpur and in F_1 & F_2 generations at Kanpur; 1000 seed weight at Kanpur in F_1 & F_2 generations and oil content in F_2 generation at Rath and in both the generations at Jabalpur. The positive and significant value of $\hat{E}$ component reflected substantial degree of environmental interaction in the expression of these traits.

The estimation of mean degree of dominance $(\hat{H}_1/\hat{D})^{0.5}$ were higher than unity (1) for technical plant height, number of tillers per plant, number of branches per plant, number of capsules per plant, number of seeds per capsule, seed weight, fibre yield per plant, oil content and seed yield per plant in both the generations at all the three locations; days to 50% flowering in F_2 at all the locations and in F_1 at Jabalpur; days to maturity in F_2 generation at all the locations, and in F_1 generation at Kanpur and plant height in both the generations at Kanpur and in F_2 generation at Rath indicated the presence of overdominance.

The proportion of genes with positive and negative effects in the parents $(\hat{H}_2/4\hat{H}_1)$ were found less than its theoratical value (0.25) for all the characters in both the generations indicating asymmetrical distribution of positive and negative genes among the parents. However, the value of plant height in F_1 generation at Rath; number of tillers per plant in F_2 generation at Jabalpur; number of branches per plant, number of seeds per capsule, harvest index in F_1 generation at Kanpur; harvest index in F_2 generation at Jabalpur and Kanpur was more than its theoratical value which indicated that harvest index showed asymmetrical distribution of genes.

The proportion of dominant and recessive genes $[(4\hat{D}\hat{H}_1)^{1/2}+\hat{F}/(4\hat{D}\hat{H}_1)^{1/2}-\hat{F}]$ was recorded in both the generations at all the three locations. Days to 50% flowering revealed more than one in both the generations at Jabalpur; days to maturity in F_1 generation at Rath and Jabalpur; plant height in F_1 generation at Rath and in both the generations at Jabalpur; technical plant height in F_2 generation at Rath and Kanpur; number of tillers per plant in F_1 generation at Jabalpur and in F_2 generation at

Rath; number of capsules per plant in F_2 generation at Rath; harvest index in both the generations at Rath and fibre yield per plant in F_2 generations at all the three locations.

The value of KD/KR was observed more than one in both the generations at all the three locations for the characters, number of seeds per capsule, 1000 seed weight, oil content and seed yield per plant reflecting the distribution of preponderance of dominance alleles for these characters. The other non-significant values showed the presence of recessive genes.

The estimates of ratio ($\hat{h}^2/\hat{H}_2$) were found to be less than unity for all the characters in both the generations except days to maturity in F_2 generation at Rath; plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, harvest index, fibre yield per plant, oil content and seed yield per plant in F_1 generation at all the three locations; technical plant and 1000 seed weight in F_1 at Kanpur. It reflected that one or more gene group was responsible for inheritance of these characters.

The negative coefficient of correlation (r) between parental order of dominance and parental measurement was found for number of tillers per plant, number of capsules per plant, 1000 seed weight, harvest index, fibre yield per plant, oil content and seed yield per plant in F_1; days to maturity in F_2 at all the three locations days to 50% flowering, number of seeds per capsule, in F_1 at Rath and Jabalpur and in F_2 at Rath and Kanpur; plant height in F_2 at Jabalpur; technical plant height in F_1 at Rath and in F_2 at Jabalpur and Kanpur; number of tillers per plant in F_2 at Rath and Jabalpur; number of branches per plant in both the generations at Rath; 1000 seed weight in F_2 at Jabalpur and Kanpur; number of capsules per plant, harvest

index and seed yield per plant in F_2 at Jabalpur showing that positive genes were mostly dominant in the expression of these traits. Number of seeds per capsule, fibre yield per plant and oil content in F_2 and days to maturity in F_1 at all the locations and remaining traits revealed positive correlation coefficient between parental order of dominance and parental measurement indicating that negative genes were mostly recessive in the expression of the characters.

COMBINING ABILITY ANALYSIS:

The analysis of variance for combining ability was computed with regard to thirteen characters in F_1 and F_2 generations separately for all the three locations. The results of the analysis are presented in table 6 (a) and 6 (b) for both the generations in order of sequence.

In F_1s, the mean sum of squares due to GCA and SCA were recorded to be highly significant for all the 13 characters for all the three locations i.e. Rath, Jabalpur and Kanpur. The estimates of GCA variances were lower than those of SCA variances for all the attributes at all the three locations except days to maturity at all the three locations, plant height at Jabalpur and Kanpur; days to 50% flowering, fibre yield per plant at Rath and Kanpur where GCA variance was higher. General predictivity ratio was observed to be less than unity with regard to all characters in both the generations at all the three locations.

The mean sum of squares in F_2 generation for GCA and SCA were recorded to be highly significant for all the 13 characters at all the three locations. The estimates of GCA variance were lower than those of SCA variance for days to

maturity, number of tillers per plant, number of capsules per plant, number of seeds per capsule, number of branches per plant, 1000 seed weight and harvest index at all the three locations and fibre yield per plant at Jabalpur.The estimates of GCA variance were higher than the SCA variance for plant height and oil content at all the three locations. Estimates of GCA variances were also higher than those of SCA variances for days to flowering and seed yield per plant at Rath and Jabalpur; technical plant height and fibre yield per plant at Rath and Kanpur.

Where the magnitude of GCA variance was higher than that of SCA variance, which might be due to additive gene action and where magnitude of SCA variance was recorded as higher than those of GCA variance revealed the role of non-additive genes for controlling the traits.

It was evident that major contribution was due to non-additive genetic variance and substantial amount of additive genetic variance was present in the expression of characters under study.

The evaluation of genotypes in particular environment consisted of considerable deviation caused due to genotypes × environment interaction. The data comprising all the locations separately in F_1 and F_2 generations for all the 13 characters are pooled together. Pooled analysis of variance for combining ability and their interaction with locations are given in table 7.

The mean sum of squares pooled over three locations for GCA, SCA and locations were highly significant for all the characters in both the generations. Significant differences were

found for GCA× Location in all the characters in both the generations.

The components of variance were calculated for 13 characters in both F_1 and F_2 crosses and the results are furnished in Table 7. The estimates of $\hat{\sigma}^2s$ revealed significant differences for days to 50% flowering, days to maturity, technical plant height, number of branches per plant, number of capsules per plant and seed yield per plant in both the generations while plant height, number of tillers per plant, 1000 seed weight, harvest index and oil content in F_1 showed significant values. The estimates of $\sigma^2\hat{g}l$ were significant for days to 50% flowering, days to maturity, plant height, technical plant height, number of branches per plant, number of capsules per plant; harvest index and seed yield per plant in both the generations, whereas 1000 seed weight in F_2 generation and fibre yield per plant in F_1 generation showed same significant differences.

The estimates of $\sigma^2\hat{g}s$ revealed significant differences for all the characters in both the generations except number of seeds per capsule, harvest index in F_2 and oil content in F_1. The $\sigma^2\hat{g}l$ interactions were less in comparision to $\sigma^2\hat{s}l$ interaction for all the characters except number of capsules per plant and harvest index in both the generations.

The presence of high estimates of $\hat{\sigma}^2g$ in comparison to $\sigma^2\hat{s}$ was observed for days to 50% flowering, plant height, number tillers per plant, fibre yield per plant in both the generations and days to maturity in F_1 while other characters revealed high estimates of $\sigma^2\hat{s}$ while comparing to $\sigma^2\hat{g}$. The $\sigma^2\hat{g}l$ interaction was comparatively less than $\sigma^2\hat{s}l$ interaction for all the attributes in both the generations indicating better stability

in these traits except number of capsules per plant, harvest index in both the generations.

The sum of interaction components $(\sigma^2\hat{g}l+\sigma^2\hat{s}l)$ exceeded the sum of genetic variance $(\sigma^2\hat{g}+\sigma^2\hat{s})$ for days to 50% flowering, days to maturity, number of capsules per plant, number of seeds per capsule, 1000 seed weight in both the generations, while characters plant height, number of tillers per plant, number of branches per plant, harvest index and oil content reflected higher values in F_2 generation.

GENERAL COMBINING ABILITY EFFECTS:

The estimates of GCA effect for 10 parents of individual location and pooled over locations (Rath, Jabalpur and Kanpur) for 13 characters in F_1 and F_2 generations are presented in Table 8. The lowest and significant values of GCA were considered to be desirable for days to 50% flowering, days to maturity, plant height and for rest of the characters the highest positive and significant values of GCA effects were regarded as guidelines to isolate the desirable general combiners. Based on this the findings are interpreted as under.

Based upon F_1 generation the desirable and significant GCA effects were observed for days to 50% flowering in parents namely, Sweta, LMH-62 and Garima at all the locations as well as in pooled analysis while Shubhra at Rath and Jabalpur, J-23 at Rath and in pooled analysis, KL-43 and LCK-88062 at Jabalpur were significant and desirable. In F_2 the parents Sweta and LMH-62 reflected significant desirable effects at all the locations and pooled over locations and the parent J-23 showed desirable effects at Rath and in pooled analysis. Parent

Garima reflected significant desirable effect at Rath, Kanpur and pooled over locations.

For days to maturity the significant and desirable GCA effects were noted in parents such as LMH-62 and RLC-6 at all the locations and pooled over locations in F_1 while Shubhra and J-23 at Rath, Jabalpur and pooled over locations; Sweta at Jabalpur, Kanpur and pooled over locations; Garima showed significant. and desirable GCA effect at Rath, Kanpur and pooled over locations based on F_1 generation. The parents Shubhra, Sweta, LMH-62, RLC-6 and Garima showed desirable and significant GCA effect in F_2 at all the locations understudy while parents J-23 at Kanpur and pooled over locations and Neelam at Rath showed significant and desirable GCA effects based on F_2 generation.

In linseed crop dwarf types were considered desirable for producing more seed yield with high oil content. Parents LMH-62 and Garima were good general combiners on the basis of significant and desirable GCA effects at all the three locations and in pooled analysis based on both the generations. Whereas, Shubhra at Jabalpur, Kanpur and pooled over locations; Sweta at Rath, Kanpur and pooled over locations were also good general combiners as judged on the same criterion on the basis of F_1 generation.

Based on F_2 parents, Sweta at Rath and Kanpur; Shubhra at Jabalpur and Kanpur and RLC-6 at Rath, Jabalpur and pooled over locations were found best general combiners on desirable and significant GCA effects basis.

Technical plant height is a desirable character for development of double purpose/ flax type varieties. Considering fibre yield as well as seed yield technical plant height is taken

into present study. Desirable and significant GCA effects were observed in parents namely DPL-21 and LCK-88062 at all the locations and pooled over locations based on F_1 and F_2 generations while KL-43 and Neelam showed the same effect based on F_2 generation.

For number of tillers per plant the significant and desirable general combiners based on F_1 were DPL-21 and KL-43 at all the locations and pooled over locations whereas Shubhra at Kanpur, Garima at Jabalpur and LCK -88062 at Rath and Jabalpur and pooled over locations. On the basis of F_2 generation, parents Shubhra at Kanpur and on pooled basis, DPL-21 at Rath, Kanpur and pooled basis and LCK-88062 at Rath and in pooled analysis exhibited desirable and significant GCA effects.

Significant and desirable combiner was LMH-62 at all the locations and in pooled analysis on the basis of both the generations. Based on F_1 generation Shubhra, Sweta, RLC-6 at Rath, Jabalpur and in pooled analysis and Garima at Jabalpur were the best general combiners for number of branches per plant. In F_2 Shubhra and Sweta exhibited desirable and significant GCA effect at Rath and Jabalpur whereas J-23 was the best general combiner at Rath, Kanpur and in pooled analysis.

For number of capsules per plant the best general combiners based on desirable and significant effects were Neelam at Rath; Kanpur and in pooled analysis; Shubhra and J-23 at Rath, Sweta and DPL-21 at Kanpur; LMH-62 at Jabalpur, Kanpur and in pooled analysis; RLC-6 at Rath and KL-43 at Rath and in pooled analysis on the basis of F_1 generation. Parents Neelam and DPL-21 at Rath, Kanpur and in

pooled analysis also; Shubhra, J-23 at Rath, Sweta at Kanpur; LMH-62 at Jabalpur, Kanpur and in pooled analysis; RLC-6 at Jabalpur and KL-43 exhibited significant desirable GCA effects at Rath, Jabalpur and in pooled analysis based on F_2 generation.

Based on F_1 hybrids, the desirable and significant GCA effects were observed for number of seeds per capsule in parents Neelam at Jabalpur and in pooled analysis; Sweta and LMH-62 at Jabalpur; RLC-6 and Garima at Rath and LCK-88062 at Rath and in pooled analysis. Whereas based on F_2 generation parent J-23 showed significant and desirable GCA effect at all the locations and in pooled analysis; parent Neelam at Jabalpur, Kanpur and in pooled analysis; Shubhra and LCK-88062 at Rath, Kanpur and in pooled analysis; Sweta, LMH-62 at Jabalpur; RLC-6 at Rath and KL-43 at Kanpur exhibited significant and desirable GCA effects.

For 1000 seed weight, the significant and desirable GCA effects were found in parents Neelam at Rath, Jabalpur and in pooled analysis; Sweta at Rath and Jabalpur; LMH-62 at Rath; J-23 and KL-43 at Kanpur and in pooled analysis and LCK-88062 at Jabalpur based on F_1 generation. On the basis of F_2 generation parents Neelam and Sweta exhibited desirable and significant GCA effects at all the three locations and in pooled analysis. Parents LMH-62 at Rath and in pooled analysis; DPL-21 at Rath; J-23 at Rath and Kanpur; Garima at Rath, Kanpur and in pooled analysis and LCK-88062 at Jabalpur showed desirable and significant GCA effects on the basis of F_2 generation.

In case of harvest index parent LMH-62 showed desirable and significant GCA effects based on both the generations. Parent Neelam showed to be best general combiner

at Rath and in pooled analysis on the basis of F_1 generation. On the basis of F_1 generation Shubhra exhibited desirable and significant GCA effect at Rath, Kanpur and in pooled analysis; J-23 at Kanpur; LCK-88062 at Jabalpur and Garima at Jabalpur and Kanpur. Based on second filial generation parents Neelam and LCK-88062 showed significant and desirable GCA effects at Rath, Jabalpur and in pooled analysis. Parents Shubhra at Rath, Kanpur and in pooled analysis; J-23 at Kanpur; Garima at Jabalpur, Kanpur and in pooled analysis and LCK-88602 at Rath, Jabalpur and in pooled analysis exhibited desirable and significant GCA effects on the basis of second filial generation.

Parents, Neelam, DPL-21, KL-43 and LCK-88062 at all the locations and pooled over locations showed significant and positive GCA effects for fibre yield per plant on F_1 generation basis while on the basis of F_2 generation parents DPL-21, KL-43 and LCK-88062 had shown the same GCA effect. Parents Neelam, at Rath, Kanpur and in pooled analysis, LMH-62 at Kanpur, RLC-6 at Jabalpur exhibited significant and desirable GCA effects based on second filial generation.

On the basis of F_1 generation significant and desirable GCA effects were found for oil content in parents such as LMH-62, and RLC-6 at all the locations and on pooled basis. Parents Shubhra and KL-43 were significant and desirable general combiner at Rath, Jabalpur and in pooled analysis whereas Sweta at Jabalpur, Kanpur and in pooled analysis also exhibited significant and desirable GCA effects. Parents Shubhra, Sweta, LMH-62 and RLC-6 at all the three locations and on pooled basis; DPL-21 at Rath; Garima at Kanpur; KL-43 at Jabalpur, Kanpur and on pooled basis showed significant and desirable GCA effects based on F_2 generation.

In case of seed yield per plant parents LMH-62, Garima and LCK-88062 exhibited desirable and significant GCA effects at all the three locations based on both the generations. Parents Shubhra at Kanpur, Sweta at Jabalpur and J-23 at Rath expressed desirable general combiners on F_1 generation basis whereas on F_2 basis Shubhra at Kanpur, Sweta at Jabalpur, J-23 at Rath, Kanpur and in pooled analysis and RLC-6 at Rath exhibited desirable and significant GCA effects.

SPECIFIC COMBINING ABILITY EFFECTS:

The estimates of specific combining ability (SCA) effects for each location and pooled over locations (Rath, Jabalpur and Kanpur) for all the 13 characters both in F_1 and F_2 progenies along with their mean performance are listed in table 9 (a) and 9 (b) respectively and the same are described as under.

Out of 45 crosses significant and desirable ~~(negative)~~ SCA effects were noted in 14 cases at Rath, 12 at Jabalpur, 10 at Kanpur while on the basis of pooled over locations 13 for days to 50% flowering in F_1 generation. Among these top 10 crosses at each location and pooled over locations are, Sweta/KL-43, LMH-62 / RLC-6, Neelam /J-23, Garima/LCK-88062, Neelam / DPL-21, DPL-21/ J-23,Shubhra / DPL-21, Shubhra / J-23, DPL-21 / RLC-6and RLC-6/Garima at Rath; Neelam / DPL-21, LMH-62 / LCK-88062, DPL-21 / LCK-88062, DPL-21 / Garima, Shubhra /J-23,LMH-62/RLC-6,RLC-6 / KL-43, LMH-62 /KL-43, RLC-6/Garima and Shubhra/LMH-62 at Jabalpur; LMH-62/ DPL-21, Shubhra / LMH-62, RLC-6 / LCK-88062, LMH-62 / RLC-6, DPL-21 / LCK-88062, J-23 / Garima, LMH-62/J-23, DPL-21/ Garima, Shubhra /RLC-6 and Sweta / DPL-21 at Kanpur; Sweta / KL-43, LMH-62 / RLC-6 , Neelam / DPL-21,

LMH-62/LCK-88062, Shubhra/LMH-62, DPL-21 / LCK-88062, Garima / LCK-88062, Shubhra / J-23 and J-23/ KL-43 on pooled basis. Amongst these cross combinations, LMH-62 / RLC-6 was the common to all the locations as well as in pooled analysis.

In second filial generation, 14 at Rath, 11 at Jabalpur, 9 at Kanpur and 12 in pooled analysis were found to be the best specific combinations. On the basis of merit, 10 superior combinations sorted out at Rath, Jabalpur and in pooled analysis but 9 at Kanpur were as Sweta / KL-43, Garima/LCK-88062, LMH-62/LCK-88062, Shubhra/DPL-21, J-23/KL-43, LMH-62/RLC-6, RLC-6/Garima, Neelam / DPL-21, Neelam/J-23, Shubhra / J-23 at Rath; Neelam / DPL-21 Sweta DPL-21, Shubhra/DPL-21, DPL-21 / KL-43, Neelam/Garima, Shubhra/RLC-6, RLC-6/LCK-88062,LMH-62/DPL-21,Shubhra/ Sweta and Neelam / KL-43 at Jabalpur; DPL-21 / RLC-6, Shubhra / LMH-62, Shubhra /J-23, DPL21/ KL-43,J-23/KL-43, LMH-62 / Garima, Sweta / LMH-62, KL43/ LCK-88062.and Neelam/J-23 at Kanpur; Shubhra/ DPL-21, Neelam /DPL-21, Sweta/KL-43, J-23 / KL-43, DPL-21 / RLC-6, Neelam / J-23, RLC-6 / Garima, Garima / LCK-88062, Shubhra /LMH-62 and J-23/LCK-88062 on pooled basis. Cross combinations Sweta/KL-43, Neelam/DPL-21, Shubhra/LMH-62 and Garima / LCK-88062 were common in both the generations on pooled basis.

The number of crosses showing significant desirable SCA effects for days to maturity in F_1 combinations were 7 at Rath, 5 at Jabalpur 12 at Kanpur and 8 in pooled analysis. Out of these cross combinations; LMH-62/DPL-21, Shubhra/ LMH-62,Sweta / J-23,RLC-6 / KL-43,Garima / KL-43, Neelam /

LMH-62 and Neelam/Sweta at Rath; LMH-62 / KL-43, J-23 / LCK-88062, Neelam/DPL-21, LMH-62 / LCK-88062 and Sweta / DPL-21 at Jabalpur; RLC-6 / KL-43,Neelam / Sweta, Neelam / Shubhra, LMH-62/KL-43/Shubhra/J-23, LMH-62 / LCK-88062, Garima/KL-43,Neelam /Garima and Sweta /DPL-21 at Kanpur; RLC-6 / KL-43, Neelam / Shubhra, Neelam / Sweta, Garima / KL-43, J-23/LCK-88062 ,Sweta / DPL-21, LMH-62 / LCK-88062 and LMH-62/KL-43 in pooled analysis showed significant desirable SCA effects.

In F_2 three crosses at Rath and 7 crosses at Kanpur had shown significant and desirable SCA effects but no any significant cross combination was observed at Jabalpur and in pooled analysis. The crosses on the basis of merit which represented desirable effects at Rath were RLC-6/KL-43, Garima/KL-43 and Sweta/RLC-6 and at Kanpur were Sweta/LMH-62, Sweta/J-23, Neelam /KL-43, DPL-21/J-23, Shubhra/DPL-21,Shubhra/LCK-88062 and RLC-6 /LCK-88062.

Limited number of significant crosses were observed for plant height two crosses each at Rath, Jabalpur and in pooled analysis and 3 crosses at Kanpur indicated significant and desirable SCA effects in F_1 generation. The crosses were RLC-6/LCK-88062 and Neelam/DPL-21 at Rath; Garima/KL-43 and J-23/KL-43 at Jabalpur; Shubhra/DPL-21,DPL-21/Garima and Neelam / LMH-62 at Kanpur and J-23/KL-43 and Shubhra/DPL-21 in pooled analysis.

In F_2 progenies 3 crosses at Rath, 6 crosses at Kanpur and non at Jabalpur revealed significant and desirable SCA effects for the trait. Out of these, ~~in~~ the order of merit at both the location were J-23/RLC-6, Neelam/Sweta and Neelam/ LMH-62 at Rath;DPL-21/Grima,Shubhra/KL-43, Neelam/Sweta,

Shubhra/LCK-88062, DPL-21/ J-23 and LMH-62/DPL-21 at Kanpur. Four crosses showed significant and desirable SCA effects in pooled analysis. In order of merit these were, Neelam/Sweta, J-23/RLC-6, Shubhra/KL-43 and LMH-62/ DPL-21.

Significant and desirable SCA effects were noted in 16 crosses at Rath, 17 at Jabalpur, 18 at Kanpur and 24 on pooled basis for technical plant height. In order of merit 10 crosses at each location and in pooled analysis were, Sweta / LCK-88062,LMH-62 / DPL-21, RLC-6 / KL-43,Sweta / DPL-21, RLC-6 / LCK-88062, DPL-21 / J23,Neelam / Sweta, DPL-21/ Garima, Neelam/RLC-6 and LMH-62 / KL-43 at Rath; Neelam / KL-43, LMH-62 /DPL-21,Sweta / DPL-21, Neelam / LCK-88062, Shubhra / DPL-21, DPL-21 / KL-43, DPL-21 / Garima, Shubhra / LCK-88062, Garima/ LCK-88062 and RLC-6 / KL-43 at Jabalpur; DPL-21 / J-23, Sweta / DPL-21, DPL-21 / KL-43, DPL-21 / RLC-6,LMH-62 /DPL-21,DPL-21 / Garima, Neelam/ Shubhra, LMH-62/LCK-88062, Neelam/RLC-6 and Neelam/ Garima at Kanpur; LMH-62 /DPL-21, Sweta / DPL-21,DPL-21/ J-23,DPL-21/Garima, DPL-21/KL-43,LMH- 62 / LCK-88062 , RLC-6/KL-43, RLC-6/LCK-88062, Neelam/KL-43, and DPL-21/ RLC-6 in pooled analysis. The combination, Sweta/DPL-21, LMH62/DPL-21 andDPL-21/Garima were common at all the locations as well as in pooled analysis.

In F_2 generation, 11 at Rath, 7 at Jabalpur 4 at Kanpur and 8 in pooled analysis revealed desirable and significant SCA effects. On the basis of merit these cross combinations were, DPL-21/KL-43, Neelam / LCK-88062, J-23 / LCK-88062, Sweta /J-23, LMH-62/ J-23, Sweta/Garima, J-23 / RLC-6,RLC-6/KL-43, DPL-21 / LCK-88062 and LMH-62/Garima

at Rath; Neelam/KL-43, Shubhra/DPL-21, J-23/Garima,Sweta/ DPL-21, Sweta/LCK-88062, Neelam/LCK-88062 and Shubhra / LMH-62 at Jabalpur ; Shubhra / DPL – 21, J-23/LCK-88062, Neelam/LMH-62 and DPL-21/KL-43 at Kanpur; Shubhra/ DPL-21,DPL-21/KL-43,DPL-21/KL-43,J-23/LCK-88062,Neelam /KL-43, Neelam/LCK-88062, J-23/Garima, Neelam/LMH-62and Sweta /Garima on pooled basis. Based on pooled analysis combinations DPL-21/KL-43 and Neelam/KL-43 were common in both the generations.

In F_1 generation, significant and desirable SCA effects for number of tillers per plant were observed in 19 combinations at Rath, 6 at Jabalpur, 19 at Kanpur and 16 on pooled basis. Amongst these 10 in order of merit were Neelam/KL-43, J-23/RLC-6, Sweta / KL-43, Shubhra / LMH-62,Shubhra / DPL-21, Sweta/ LCK-88062, DPL-21/ Garima, DPL-21/J-23, LMH-62 / Garima and Sweta / Garima at Rath; Neelam/ LCK-88062, J-23/LCK-88062, DPL-21/Garima, LMH-62/KL-43, Shubhra/KL-43, and LMH-62/LCK-880662 at Jabalpur; Sweta / DPL-21,Shubhra/Sweta, Sweta/KL-43, Neelam/KL-43, DPL-21/ J-23, Shubhra / DPL-21, J-23 / LCK-88062, LMH-62/KL-43, Shubhra/LCK-88062 and KL-43/LCK-88062 at Kanpur; J-23 / LCK-88062, DPL-21/Garima, Neelam/KL-43, J-23/RLC-6, Neelam/LCK-88062, Sweta/KL-43, Sweta/Garima, Shubhra/ DPL-21, DPL-21 /J-23 and Shubhra / LMH-62 on pooled basis.

In F_2 population 11 crosses at Rath and one each at Jabalpur and Kanpur and 2 on pooled basis exhibited significant and desirable specific effects. In order of merit 11 combinations were RLC-6 / Garima, Neelam / KL-43, Shubhra / LMH-62, J-23/ LCK-88062, Neelam/ LMH-62,Sweta / RLC-6,Shubhra/ DPL-21,Sweta/LCK-88062, LMH-62/ RLC-6 and Sweta/KL-43 at

Rath; Neelam / Shubhra at Jabalpur; Shubhra/ Garima at Kanpur and Neelam/ Shubhra and J-23/LCK-88062 on pooled basis where J-23 /LCK-88062 was common combination in F_1 and F_2 generations.

In case of number of branches per plant, the crosses which exhibited significant and desirable SCA effects were 22 in number at Rath and Jabalpur, 5 at Kanpur and 20 on pooled over locations in first filial generation. Out of these, 10 in order of merit were DPL-21/RLC-6, Shubhra/RLC-6,Sweta/J-23, RLC-6/Grima, Neelam / LCK-88062, Sweta /LMH-62, Shubhra/ KL-43, J-23/KL-43, LMH-62/J-23 and Sweta/DPL-21 at Rath; Shubhra / Sweta, Neelam / RLC-6, DPL-21/Garima, Neelam/ Sweta,LMH-62/LCK-88062,DPL-21/RLC-6, Shubhra /Garima , Shubhra / LMH- 62, LMH- 62 / J - 23 and Shubhra/RLC-6 at Jabalpur; Shubhra/LMH-62,J-23/LCK-88062, Sweta/LMH-62, Neelam/ LMH-62 and Shubhra /Sweta at Kanpur; DPL-21/ RLC-6,Shubhra/RLC-6,Shubhra/Sweta,Shubhra/LMH-62, Sweta/J-23, DPL-21/Garima, Sweta/LMH-62 , Neelam/Sweta, J-23/KL-43 and J-23 / LCK-88062 on pooled basis.

In F_2 progenies 9 combinations at Rath, 8 at Jabalpur, nil at Kanpur and 4 on pooled basis were found to be the best specific combiners. Out of these 9 in order of merit, were DPL-21/RLC-6, Shubhra/RLC-6, Neelam/KL-43, Neelam / LCK-88062, Sweta /J-23, Sweta/LMH-62, Shubhra/J-23, LMH-62/DPL-21 and LMH-62/J-23 at Rath; Neelam/RLC-6, Shubhra/Sweta,Shubhra/Garima,Neelam/Sweta,DPL-21/KL-43 ,Shubhra/LMH-62, DPL-21 / LCK-88062 and Shubhra/DPL-21 at Jabalpur; and nil at Kanpur were observed . The 4 combinations on pooled basis were DPL-21/RLC-6, LMH-62/ J-23, DPL-21/KL-43 and LMH-62/LCK-88062. In pooled

analysis in both the generations DPL-21/RLC-6 was common combination.

In respect of number of capsules per plant 9 crosses at Rath; 19 at Jabalpur, 15 at Kanpur and 21 on pooled basis exhibited significant and desirable SCA effects in F_1 generation. Nine crosses in order of merit, were LMH-62/ Garima, Shubhra/J-23, Neelam/RLC-6, LMH-62/J-23 ,Sweta /Garima, LMH-62 / LCK-88062, Shubhra / DPL-21, DPL-21 / RLC-6and Neelam/DPL-21 at Rath; 10 crosses at Jabalpur were Shubhra/ LMH-62,LMH-62/J-23,Shubhra/RLC-6,DPL-21/ RLC-6 ,Sweta / KL-43, Neelam/KL-43, Shubhra/Sweta, RLC-6/KL-43, Neelam / Garima and J-23/RLC-6; 10 crosses at Kanpur were Sweta/ LCK-88062, Sweta/KL-43, Shubhra/Garima, Neelam/ DPL-21, RLC-6/LCK-88062,Shubhra/J-23,Shubhra/ LMH-62, LMH-62 / Garima , DPL-21/Garima and Sweta/DPL-21 and 10 crosses on pooled basis were Shubhra/LMH-62, Sweta/KL-43, LMH-62/ J-23, LMH-62/Garima, Sweta/LCK-88062, Shubhra/DPL-21, Shubhra/J-23,Shubhra/RLC-6, Neelam /DPL-21 and RLC-6/ LCK-88062.

In F_2 progenies, 4 crosses at Rath, 19 at Jabalpur, 6 at Kanpur and 11 on pooled basis were screened out as desirable specific combiners as these combinations showed significant SCA effects. Among these 4 cross combinations at Rath, in order of ranking were Shubhra/RLC-6, Shubhra/J-23, Sweta/ LCK-88062 and Shubhra/ DPL-21; 10 combinations at Jabalpur were Shubhra/RLC-6,Shubhra/LMH-62,LMH-62/J-23, Shubra/ DPL-21, LMH-62/Garima, Shubhra/ DPL-21, DPL-21/J-23, Sweta/KL-43, J-23/LCK-88062 and LMH-62 / RLC-6 and 10 top ranking combinations at Kanpur location were Sweta/J-23, Neelam/Garima, Shubhra/LMH–62 Shubhra/DPL-21,RLC-6/

LCK-88062 and Garima /KL-43. Ten desirable and significant crosses in order of merit in pooled analysis were Shubhra/ RLC-6, Shubhra/DPL-21,LMH-62/Garima, Sweta/J-23,Neelam/ Garima, Shubhra/LMH-62, LMH-62/LCK-88062, LMH-62/J-23, Sweta/KL-43 and Garima/KL-43. Combinations Shubhra/ DPL-21,Shubhra/LMH-62,Sweta/KL-43,LMH-62/J-23,LMH-62/ Garima and LMH-62/RLC-6 were common specific combiner at all the locations and pooled over locations at both the generations which meant that these combinations were most stable for number of capsules per plant.

In case of number of seeds per capsule, 18 crosses at Rath; 13 crosses at Jabalpur; 3 crosses at Kanpur exhibited significant and desirable SCA effects in F_1 generation. Eleven crosses, in order of merit at Rath and Jabalpur locations were Shubhra/LMH-62, Neelam / KL-43, DPL-21/KL-43, DPL-21/ J-23, Neelam / RLC-6, Shubhra / KL-43,LMH-62 / Garima, Shubhra/Sweta,Sweta/LCK-88062, Neelam/J-23 and Shubhra/ Garima at Rath; Shubhra/LMH-62, Sweta/Garima, Sweta/ LCK-88062, Shubhra / Sweta, Neelam / RLC-6, Neelam/KL-43, LMH-62 / J-23,Neelam/J-23,DPL-21/LCK-88062, Sweta/J-23 and LMH-62/LCK-88062 at Jabalpur; three cross combinations in order of merit at Kanpur were Sweta/ KL-43, LMH-62/J-23 and J-23/LCK-88062. Cross combinations LMH-62/ J-23, Neelam/J-23,Neelam/KL-43, Shubhra/ LMH-62, Sweta/Garima, J-23/LCK-88062, DPL-21/J-23, Sweta/KL-43, Shubhra/RLC-6 and Shubhra/KL-43 were the best specific cross combinations on pooled basis.

In F_2 progenies 10 ~~cases~~ at Rath 9 at Kanpur, 7 at Jabalpur and 12 on pooled basis were noted for desirable and significant SCA effects. Ten crosses, in order of ranking at Rath

were Shubhra/LMH-62, Neelam/LCK-88062, Shubhra/Garima, Neelam/KL-43, DPL-21 / RLC-6, DPL-21/J-23, J-23/Garima, Sweta/DPL-21, Neelam/J-23 and Shubhra/Sweta; 7 crosses, in order of ranking at Jabalpur were LMH-62/J-23, Neelam/ LMH-62, Shubhra/Sweta, Garima/KL-43, Neelam / Sweta, DPL-21/Garima and DPL-21/KL-43; Nine crosses, in order of merit at Kanpur were Neelam/J-23, Shubhra/Sweta,DPL-21/ LCK-88062, Neelam/RLC-6, Sweta/KL-43,J-23/KL-43, Sweta/ DPL-21, RLC-6 / KL-43 and Sweta / LCK-88062. Cross combination Shubhra / Sweta was common at all the three locations and pooled over locations.

In case of thousand seed weight, the number of crosses which revealed significant and desirable SCA effects were, 26 at Rath and 12 at Jabalpur but not even a single combination was observed at Kanpur and in pooled analysis in F_1 generation. Out of those ten superior specific combiners in order of preference were Neelam / LCK-88062, Neelam / RLC-6, LMH-62/RLC-6, DPL-21/LCK-88062, Shubhra/Sweta, Sweta/ KL-43, RLC-6/KL-43, Garima/KL-43, Shubhra/RLC—6 and Garima/LCK-88062 at Rath; Sweta /J-23, Shubhra/LCK-88062, Sweta/KL-43, J-23/LCK-88062, Neelam/J-23, LMH-62/DPL-21, RLC-6 / Garima, LMH-62 / Garima, Garima /LCK-88062 and J-23/KL-43 at Jabalpur.

In F_2 generations, 10 at Rath, 8 at Jabalpur, 12 at Kanpur and 14 on pooled basis showed significant and desirable SCA effects. Out of these, eight crosses namely, Neelam/ Shubhra,Neelam/Sweta,DPL-21/LCK-88062,RLC-6/LCK-88062, KL-43/LCK-88062, DPL-21/J-23, RLC-/KL-43 and Shubhra/ LCK-88062, at Rath; J-23/KL-43, Shubhra/DPL-21, Sweta / KL-43, LMH-62/Garima, Shubhra/Sweta, RLC-6/LCK-88062,

Neelam/ Garima and Sweta/J-23 at Jabalpur; LMH-62/KL-43, LMH-62/Garima, Sweta/J-23, Garima/LCK-88062, LMH-62/ DPL-21, Shubhra/Garima, Shubhra/ RLC-6 and RLC-6/ LCK-88062 at Kanpur; LMH-62/Garima, LMH-62/ KL-43, J-23/KL-43, Sweta/J-23, RLC-6/LCK-88062, Shubhra/DPL-21, Neelam/Shubhra and LMH-62/LCK-88062 on pooled basis were the superior specific combiners in order of preference. Among them, cross RLC-6/LCK-88062 was the best combiner as its prevalence was common at all the three locations and pooled over the locations.

The number of crosses which revealed significant and desirable SCA effects for harvest index were 5 at Rath and Kanpur, 11 at Jabalpur and 14 on pooled basis. Five crosses in order of merit ~~in~~ at each location and on pooled basis were LMH-62/DPL-21, LMH-62/RLC-6,DPL–21/KL-43,Sweta/DPL-21 and J-23/KL-43at Rath;DPL-21/Garima, LMH-62/J-23, Sweta/ LMH-62, Neelam / J-23 and J-23/ LCK-88062 at Jabalpur; Sweta/LMH-62,Shubhra/Sweta,LMH-62/RLC-6, RLC-6/Garima and DPL-21/ J-23 at Kanpur; LMH-62 / RLC-6, Sweta/LMH-62, DPL-21/Garima, Shubhra/LCK-88062 and LMH-62/DPL-21 on pooled basis. Cross combination, LMH-62/RLC-6 was common at all the three locations and pooled over locations therefore, it was ~~the~~ most stable for harvest index in different agroclimatic situations.

In F_2 progenies, 6 cross combinations at Rath, 3 at Jabalpur, 1 at Kanpur and 4 on pooled basis were recorded with desirable and significant SCA effects. Cross combinations Neelam /Sweta and J-23 / KL-43 at Rath; LMH-62/RLC-6 and J-23/ LCK-88062 at Jabalpur; Garima/KL-43 at Kanpur and

LMH-62/RLC-6 were found to be best specific combiners on the basis of merit.

Significant and desirable SCA effects were noted in 25 cross combinations at Rath, 19 at Jabalpur, 24 at Kanpur and 24 on pooled basis in F_1 for fibre yield per plant. Among these, the maximum SCA effects in order of ranking were contributed in 10 crosses at each location and in pooled analysis namely, Sweta/DPL-21, DPL-21/Garima, Shubhra/Sweta, Sweta/J-23, LMH-62 / LCK-88062, Sweta/LCK-88062, RLC-6/ KL-43, DPL-21 /RLC-6 and LMH-62/KL-43 at Rath; Neelam / KL-43, Shubhra/DPL-21, Sweta/ DPL-21, LMH-62/ KL-43, LMH-62 / DPL-21, Shubhra / LCK-88062, Sweta / LCK-88062, RLC-6/KL-43, RLC-6/LCK-88062 and LMH-62/LCK-88062 at Jabalpur; Shubhra/DPL-21, Shubhra/KL-43, LMH-62/DPL-21, DPL-21/J-23, DPL-21/Garima, Shubhra/LCK-88062, RLC-6/ KL-43,Sweta/LCK-88062, J-23/KL-43, and LMH-62/LCK-88062 at Kanpur; Shubhra/DPL-21, LMH-62/DPL-21, Sweta/DPL-21, Shubhra/LCK-88062, Sweta/LCK-88062, RLC-6/KL-43,LMH-62 /KL-43,DPL-21/ Garima,LMH-62/LCK-88062 and DPL-21/J-23 on pooled basis. Cross combinations, Sweta/LCK-88062, LMH-62/DPL-21, LMH-62/LCK-88062 and RLC-6 /KL-43 were the common to all the locations as well as in pooled analysis showing the stability for fibre yield per plant in different agroclimatic situations.

In F_2 progenies 17 cross combinations at all the three locations and pooled over locations showed significant and desirable SCA effects. Out of these ten crosses namely Neelam / RLC-6, DPL-21 / Garima, Shubhra / Sweta, J-23 / LCK-88062, LMH-62/J-23, Sweta/J-23, Shubhra/RL-6, Neelam/DPL-21, Shubhra/LCK-88062 and Shubhra / Garima at Rath;LMH-62/

LCK-88062, Shubhra/DPL-21, Shubhra/LCK-88062, Sweta/ LCK-88062, LMH-62/DPL-21, Neelam/KL-43, LMH-62/KL-43, DPL-21/Garima, J-23/KL-43 and DPL-21/J-23 at Jabalpur; DPL-21/LCK-88062, Neelam/LMH-62, Shubhra/Garima,Sweta/ Garima, Sweta/RLC-6, J-23/RLC-6, RLC-6/Garima, Neelam/ KL-43, Sweta/J-23/and J-23/Garima at Kanpur; DPL-21/ LCK-88062, Neelam / KL-43, Shubra/RLC-6, Sweta / J-23, Shubhra/Sweta, J-23/RLC-6, Shubhra/LCK-88062, Sweta/ RLC-6 , Shubhra /Garima and J-23 /Garima on pooled basis were the superior specific combiners in order of preference.

The number of crosses which revealed significant and desirable SCA effects for oil content were 10 at Rath, 13 at Jabalpur, 19 at Kanpur and 21 on pooled basis in F_1 generation. These were J-23/LCK-88062, J-23/RLC-6,J-23/KL-43,Neelam / LMH-62, DPL-21/J-23, Sweta/J-23, Garima/LCK-88062 and KL-43/LCK-88062 at Rath; LMH-62/LCK-88062, Shubhra/ RLC-6, Garima/LCK-88062,J-23/KL-43, Neelam/Sweta, Sweta/ LMH-62, Sweta/KL-43 and Neelam /LMH-62 at Jabalpur; DPL-21/RLC-6, Sweta/DPL-21, Neelam/LMH-62, Sweta/ LCK-88062, Shubhra /LMH-62, Sweta/J-23, J-23/RLC-6, and LMH-62/ DPL-21 at Kanpur; Neelam /LMH-62, J-23/KL-43, J-23/RLC-6 , DPL-21/RLC-6, J-23/LCK-88062, LMH-62/ LCK-88062, Sweta/ J-23 and Garima/LCK-88062 on pooled basis. In these crosses Neelam / LMH-62 was the best specific combiner as it contributed significant values at all the locations and pooled over the locations.

In F_2 progenies, 3 at Rath, 9 at Jabalpur, 4 at Kanpur and five on pooled basis reflected significant and desirable SCA effects. Cross combinations in order of ranking, were Neelam/ J-23, J-23 / RLC-6and Garima /L CK-88062 at Rath; Garima/

LCK-88062, Neelam/RLC-6, Shubhra/Sweta, Neelam/Shubhra, Sweta/LMH-62 and Sweta /KL-43 at Jabalpur; Neelam / RLC-6, Neelam/J-23, Shubhra/Sweta and J-23 /Garima at Kanpur; Neelam/J-23,Neelam/RLC-6,Garima/LCK-88062 and Shubhra / Sweta on pooled basis showed desirable and significant SCA effects in F_2 generation.

In respect of seed yield per plant, the number of crosses which indicated significant and desirable SCA effects in F_1 generation were 22 at Rath, 18 at Jabalpur, 20 at Kanpur and 26 on pooled basis. Out of these, 10 crosses at each location and on pooled basis were Shubhra/LMH-62, LMH-62/DPL-21, Sweta/LCK-88062,Sweta/LMH-62,Sweta/Garima,DPL-21/ J-23, DPL-21/Garima, J-23/KL-43, Sweta/KL-43 and DPL-21/ RLC-6 at Rath; Shubhra/LMH-62, LMH-62/J-23, Sweta/J-23,DPL-21/ RLC-6, RLC-6 / Garima, Sweta / LCK-88062, Shubhra / KL-43, Shubhra/Sweta, Shubhra/Garima and DPL-21/LCK-88062 at Jabalpur; LMH-62/DPL-21, Sweta/LMH-62, Neelam/RLC-6, Sweta/LCK-88062, Shubhra/J-23, Shubhra/RLC-6, DPL-21/ J-23, RLC-6 /Garima,DPL-21/Garima and Neelam/LCK-88062 at Kanpur; Sweta/LCK-88062, LMH-62/DPL-21, Neelam/ LMH-62, Sweta/LMH-62, Shubhra/LMH-62, RLC-6/Garima, DPL-21/J-23, Shubhra/RLC-6, LMH-62/RLC-6 and DPL-21/ Garima on pooled basis. Amongst these, cross Sweta/ LCK-88062 was the best specific combiner as it contributed highest value at all the locations and pooled over the locations coupled with Shubhra/LMH-62, Sweta/LMH-62, LMH-62/ DPL-21, DPL-21/J-23, DPL-21/RLC-6, DPL-21/Garima and RLC-6/ Garima at least in two locations and on pooled basis.

In F_2 progenies 19 crosses at Rath, 12 at Jabalpur, 17 at Kanpur and 15 on pooled basis reflected significant and

desirable SCA effects. The cross combinations, in order of ranking, were DPL-21/RLC-6, Sweta/Garima, Garima/KL-43, J-23/KL-43, Neelam/ Shubhra, LMH-62/KL-43,DPL-21/ J-23, Sweta/KL-43,J-23/LCK-88062 and Neelam/LCK-88062 at Rath; Shubhra/Sweta, Shubhra/Garima,LMH-62/DPL-21,Sweta/J-23, J-23 / LCK-88062, Shubhra / KL-43, RLC-6 / Garima,RLC-6 / LCK-88062, J-23/Garima and DPL-21 / RLC-6 at Jabalpur; DPL-21/RLC-6, Sweta/LCK-88062, Shubhra/J-23, Garima/ KL-43, Neelam/Garima, Neelam/RLC-6, KL-43/LCK-88062, J-23/ Garima , Sweta/LMH-62, and Neelam/LCK-88062 at Kanpur; DPL-21 / RLC-6, Garima / KL-43, Neelam / Shubhra, Neelam/LCK-88062,LMH-62/DPL-21,Shubhra/Garima,DPL-21/ J-23, J-23/Garima, Neelam/ RLC-6 and Sweta/DPL-21 on pooled basis. The cross combination DPL-21/RLC-6 exhibited desirable and significant SCA effects at all the locations and on pooled basis.

HETEROSIS AND INBREEDING DEPRESSION:

Heterosis was determined over the superior parent and mid parent while inbreeding depression was calculated in F_2 generation for all the 13 characters individually for each location and on pooled basis. The results on above parameters are furnished in table 10.

Days to 50% flowering manifested heterosis over superior parent (SP) from -22.01 to 59.01 percent at Rath; 8.65 to 31.10 percent at Jabalpur,-4.0 to 14.90 percent at Kanpur and –6.96 to 56.57 percent on pooled basis. Eight hybrids at Rath, 5 at Jabalpur, 2 at Kanpur and 4 on pooled basis exhibited significant negative heterosis indicating early flowering in these crosses over the superior parent. Five hybrids in order

of merit at Rath were DPL-21 / KL-43, Sweta / LCK-88062, Shubhra/LCK-88062,Shubhra/DPL-21 and RLC-6/LCK-88062; at Jabalpur were RLC-6/LCK-88062, Shubhra/LCK-88062, Neelam/DPL-21, DPL-21/J-23 and Garima/KL-43; 2 hybrids at Kanpur were Sweta/LMH-62 and DPL-21/LCK-88062 and on pooled basis three hybrids were Shubhra/LCK-88062, RLC-6 /LCK-88062 and DPL-21/KL-43.

Heterosis over mid parent (MP) was observed from –29.59 to 56.57percent at Rath, -9.87 to 22.86 percent at Jabalpur, –18.78 to 12.47 percent at Kanpur and –12.07 to 23.23 percent on pooled basis Fifteen hybrid combinations at Rath, 13 at Jabalpur, 26 at Kanpur and 14 on pooled basis exhibited negative and significant heterosis indicating early flowering in these crosses over the mid parent .In order of merit, at each location five hybrids were DPL-21/KL-43, Shubhra/ DPL-21, Sweta/DPL-21, Shubhra/LCK-88062 and DPL-21/ RLC-6 at Rath;RLC-6/LCK-88062, DPL-21/J-23, Shubhra/ DPL-21, Neelam / DPL-21 and DPL-21 / KL-43 at Jabalpur ; LMH-62/DPL-21, Shubhra/LMH-62, LMH-62/RLC-6, Sweta/ DPL-21,LMH-62/LCK-88062 and DPL-21/LCK-88062 at Kanpur and DPL-21/KL-43, Shubhra/DPL-21, Sweta/DPL-21, RLC-6/ LCK-88062 and Shubhra / LCK-88062 on pooled basis. Cross combinations Neelam/DPL-21, DPL-21/LCK-88062 and RLC-6/ LCK-88062 exhibited heterosis over mid parent at all the locations and on pooled over locations.

Inbreeding depression was found to be significant and negative in 18 combinations ranging from –31.68 to 25.59 percent at Rath, 32 at Jabalpur ranging from –30.77 to 11.43 percent; 34 at Kanpur ranging from –45.66 to 9.52 percent and 31 ranging from –24.68 to 08.80 percent on pooled basis. Five F_2

at each location showing maximum depression were Neelam/ J-23, DPL-21/KL-43, Sweta/DPL-21, Shubhra/LCK-88062 and Garima / LCK-88062 at Rath; RLC-6 / LCK-88062, Sweta/ LCK-88062, Shubhra/ Sweta,Garima/LCK-88062 and Sweta/ J-23 at Jabalpur; LMH-62/DPL-21,LMH-62/LCK-88062, Sweta/ DPL-21,LMH-62/J-23 and LMH-62 /RLC-6 at Kanpur and Sweta/DPL-21,Sweta/LCK-88062,Neelam/J-23,Sweta/J-23 and Shubhra / LCK-88062 on pooled basis.

In case of days to maturity, significant heterosis over superior parent ranged from-4.63 to 16.48 percent at Rath; from 8.71 to 16.67 percent at Jabalpur; from 2.36 to 11.36 percent at Kanpur and from 4.22 to 11.13 percent in pooled analysis. Cross Shubhra/Sweta contributed maximum heterosis followed by Sweta/KL-43 and Sweta/LCK-88062 at Rath. On the other hand significant and negative heterosis over mid parent was from -5.60 to 12.32 parent at Jabalpur and from -2.12 to 9.55 parent at Kanpur. Crosses Shubhra / Sweta followed by Shubhra / DPL-21 and Sweta / KL-43 contributed maximum heterosis over mid parent at Rath and DPL-21/RLC-6 at Kanpur.

In case of inbreeding depression five F_2s (Shubhra/ LCK-88062,Sweta/KL-43,LMH-62/DPL-21,Shubhra/ J - 23 and DPL-21/KL-43) at Rath; five F_2s (LMH-62/DPL-21 , LMH-62/ KL-43, Sweta/KL-43, DPL-21 /RLC-6 and RLC-6/ KL-43)at Kanpur and six F_2 s (Sweta/KL-43, Garima/KL-43, LMH-62/ DPL-21, DPL-21/KL-43, Shubhra/LCK-88062 and RLC-6/ LCK-88062) on pooled basis indicated significant negative inbreeding depression ranging from-23.43 to 4.28 percent at Jabalpur; -13.40 to 5.30 percent at Kanpur and–10.64 to 5.42 on pooled basis in order of preference.

The significant and negative heterosis over superior parent for plant height was noted in three crosses (KL-43/ LCK-88062, Garima / KL-43, and Garima/LCK-88062) at Rath with heterotic range from –41 to 70.42 percent. On the other hand significant and negative heterosis over mid parent ranged from -43.65 to 67.80 percent at Rath with 5 combinations, namely KL -43 / LCK-88062, Garima / LCK-88062, Sweta / LCK-88062 and RLC-6 /LCK-88062; from-14.56 to 45.51 percent with 4 combinations namely Garima/LCK-88062, Sweta/LCK-88062, Garima/KL-43,DPL-21/Garima at Jabalpur and one combination KL-43/LCK-88062 in pooled analysis ranging from -12.52 to 42.30 percent.

Out of 45 F_2s, 6 at Rath,13 at Jabalpur; 2 at Kanpur and 5 on pooled basis revealed significant and negative inbreeding depression ranging from-53.40 to 42.30, -48.16 to 32.20, 31.48 to 27.12 and-19.52 to 32.00 percent respectively. Cross combinations, in order of merit were KL-43/LCK-88062, RLC-6/LCK-88062, Garima/LCK-88062, Garima/KL-43 and Sweta / LCK-88062 at Rath; DPL-21/LCK-88062 and Shubhra/ J-23 at Jabalpur; Shubhra/DPL-21 and Shubhra/Sweta at Kanpur; RLC-6/LCK-88062 and Shubhra/Sweta on pooled basis.

In case of technical plant height, 17 at Rath, 30 at Jabalpur, 37 at Kanpur and 30 on pooled basis revealed significant and positive heterosis. The range of hybrid vigour was –36.68 to 100.54 percent at Rath; -15 to 62.08 percent at Jabalpur; -70.57 to 29.62 percent at Kanpur and –18.99 to 47.24 percent in pooled analysis. In order of sequence crosses, Neelam / Garima, Neelam / LCK-88062, Shubhra / LMH-62, Shubhra / KL-43, Sweta / J-23,Sweta / RLC-6, Sweta / Garima,

LMH-62/DPL-21,LMH-62/J-23, LMH-62/RLC-6 and LMH-62/ Garima exhibited significant and positive heterosis over superior parent at all the locations and pooled over locations.

Similarly in case of heterosis over mid parent 33 crosses ranging from-28.06 to 105.73 percent at Rath, 38 crosses ranging from-11.01 to 71.23 percent at Jabalpur, 41 crosses ranging from 66.59 to 47.98 percent at Kanpur and 41 crosses ranging from 5.42 to 57.47 percent on pooled basis showed significant and positive heterosis. Twenty three crosses exhibited positive and significant heterosis at all the three locations and pooled over locations. Out of which, on the basis of merit 5 top cross combinations were Sweta/Garima, LMH-62/ RLC-6, Sweta/RLC-6, LMH-62/Garima and LMH-62/ J-23.

Out of 45 F_2s, 21 at Rath; 26 at Jabalpur,31 at Kanpur and 25 on pooled basis revealed significant and positive inbreeding depression ranging from -85.64 to 39.91; -32.69 to 61.20,-174.92 to 46.61 and –34.27 to 32.65 percent, respectively. Five cross combinations in order of merit were LMH-62/J-23,LMH-62/DPL-21, Neelam/Sweta, LMH-62/RLC-6, Neelam/LMH-62 at Rath; Shubhra/J/23, Neelam/KL-43, Neelam/DPL-21, Sweta/Garima and Sweta/RLC-6 at Jabalpur; DPL-21/LCK-88062, Sweta/DPL-21, DPL-21/Garima,DPL-21/ RLC-6 and LMH-62/ DPL-21 at Kanpur; LMH-62/DPL-21, Neelam/ Garima, Neelam/Sweta, Neelam/RLC-6 and LMH-62/ J-23 at all the three locations and pooled over locations showed significant and positive inbreeding depression.

Significant and positive heterosis over superior parent in 21,14,44 and 25 crosses were seen at Rath, Jabalpur, Kanpur and in pooled analysis for number of tillers per plant. The range of heterosis over superior parent varied in percent

from -56.00 to 96.36 at Rath;-40.46 to 97.12 at Jabalpur; -25.63 to 39.60 at Kanpur and –21.33 to 68.71 on pooled basis. Among these five significant and positive crosses in order of merit were LMH-62/RLC-6, Shubhra/LMH-62, Sweta/RLC-6, LMH-62/J-23 and Sweta/J-23 at Rath; LMH-62/RLC-6, LMH-62/J-23, LMH-62/Garima, LMH-62/KL-43 and Shubhra/RLC-6 at Jabalpur; Neelam/LCK-88062, Neelam /LMH-62, LMH-62/ LCK-88062, Neelam/RLC-6 and Neelam/KL-43 at Kanpur and LMH-62/RLC-6,LMH-62/J-23,LMH-62/KL-43,Shubhra/LMH-62 and LMH-62/Garima on pooled basis. On the basis of merit out of 9 crosses 5 crosses common to all the three locations and pooled over locations were LMH-62/RLC-6, LMH-62/J-23, LMH-62 /KL-43, Shubhra/LMH-62 and LMH-62/ Garima.

Significant and positive heterosis over mid parent was observed in 30,23,44 and 37 F_1s with the range in percent –51.80 to 103.91. –35.42 to 109.16 and -12.39 to 70.51 at all the three locations and in pooled analysis, respectively. Among these19 combination exhibited significant and positive heterosis over mid parent at all the three locations and pooled over locations. The five crosses in order of merit were LMH-62/RLC-6, LMH-62/KL-43, LMH-62/J-23, Neelam/LMH-62and LMH-62/ Garima. Among the significant and positive average heterosis five best combinations at each location were LMH-62/RLC-6, Sweta/RLC-6, Sweta/J-23, Shubhra/LMH-62 and LMH-62 at J-23 at Rath; LMH-62/RLC-6, LMH-62/KL-43, LMH-62/ Garima, LMH-62/J-23 and Neelam/LCK-88062 at Jabalpur; Sweta/DPL-21, Sweta/KL-43, Shubhra/Sweta, Neelam/KL-43 and KL-43/LCK-88062 at Kanpur and on pooled basis significant at positive heterotic combinations were LMH-62/

RLC-6, LMH-62/KL-43, LMH-62/J-23, Shubhra/LMH-62 and LMH-62/ Garima.

Thirty two ,17,43 and 30 F_2 s showed significant and positive inbreeding depression at Rath, Jabalpur, Kanpur and pooled over the locations, respectively. The range varied from -38.77 (Neelam/ J-23) to 56.16 (Neelam/DPL-21) percent at Rath; -74.89 (DPL-21/KL-43) to 35.07 (Neelam/Garima) percent at Jabalpur; -40.47 (Shubhra/Garima) to 31.63 (Neelam/DPL-21) at Kanpur and –22.79(J-23/RLC-6) to 37.59 (Neelam/DPL-21) on pooled basis. Five cross combinations in order of ranking in F_2 generation, recorded maximum significant reduction namely, Neelam/DPL-21, Shubhra/LMH-62, LMH-62/DPL-21, Neelam / LCK-88062 and Neelam/Garima on pooled basis.

The range of significant heterosis over superior parent varied from-6.25 to 88.56 percent at Rath; -13.69 to 124.03 percent at Jabalpur; -21.90 to 53.64 percent at Kanpur and 5.87 to 61.11 in pooled analysis for number of branches per plant. Fourty three crosses at Rath, 40 at Jabalpur and 38 at Kanpur revealed positive and significant heterosis over superior parent. Five F_1s in order of merit, at each location were Shubhra/J-23,LMH-62/J-23,Shubhra/LCK-88062,Sweta/KL-43 and Shubhra/DPL-21 at Rath; Neelam/RLC-6, LMH-62/RLC-6 , Shubhra/RLC-6, J-23/ RLC-6 and LMH-62/J-23 at Jabalpur; Shubhra /Sweta,J-23/Garima,Garima/KL-43,Shubhra/LMH-62 and DPL-21/Garima at Kanpur and thirty combinations were significantly common at all the three locations and pooled over locations out of which five combinations on merit basis were Shubhra/Sweta, Shubhra/J-23, Shubhra/LCK-88062,LMH-62/ J-23 and Neelam/RLC-6.

Significant and positive heterosis over mid parent in 44,42,43 and 45 crosses were seen at Rath, Jabalpur, Kanpur and in pooled analysis. The range of heterosis over mid parent at all the three locations varied from 6.01 to 97.60, 5.54 to 127.41, 6.79 to 66.42 and 13.87 to 77.01, respectively. Five cross combinations in order of merit at each location were Shubhra / LCK-88062, Shubhra/J-23, LMH-62/J-23 Sweta/KL-43 and Sweta/LCK-88062 at Rath; Neelam/RLC-6, LMH-62/RLC-6, Shubhra/LCK-88062, Sweta /LCK-88062 and LMH-62/J-23 at Jabalpur; J-23/LCK-88062, Shubhra/Sweta, Shubhra/LMH-62, Sweta/LMH-62 and DPL-21/LCK-88062 at Kanpur; Shubhra/ LCK-88062,Shubhra/J-23,Shubhra/Sweta, Sweta /LCK-88062 and RLC-6/LCK-88062 on pooled basis. Thirty nine F_1s revealed significant and positive heterotic response over mid parent was observed commonly at all the three locations and pooled over locations.

Out of 45 F_2 s, 27 at Rath, 37 at Jabalpur, 42 at Kanpur and 36 on pooled basis revealed significant and positive inbreeding depression ranging from-29.01 to 56.51, -23.38 to 62.69, -16.25 to 42.95 and 8.33 to 48.19 percent at Rath, Jabalpur, Kanpur and on pooled basis, respectively. Thirty five combinations revealed positive and significant inbreeding depression at all the three locations and pooled over locations. In order of merit five combinations were Shubhra/LCK-88062, Sweta / LCK-88062, Neelam / LCK-88062, Shubhra / J-23 and RLC-6 /LCK-88062 at Rath; Neelam /Sweta, Neelam/LMH-62, Garima/LCK-88062, Sweta/LCK-88062 and LMH-62/RLC-6 at Jabalpur; LMH-62/RLC-6, Shubhra/LMH-62, Sweta/LMH-62, J-23 /LCK-88062 and Neelam/LCK-88062 at Kanpur and

Shubhra / LCK-88062, Garima / LCK-88062, Neelam / Sweta, Neelam/ LMH -62 and Neelam/RLC-6 on pooled basis.

In case of number of capsules per plant, heterosis over superior parent ranged from -17.92 to 28.53 percent at Rath;-26.09 to 89.38 percent at Jabalpur; -10.71 to 62.71 percent at Kanpur and -8.96 to 39.96 percent on pooled basis positively and significantly. Ten cross combinations revealed significant and positive heterotic response at all the three locations and pooled over locations with maximum heterosis shown by Sweta/KL-43 followed by Shubhra/Sweta, Sweta/ DPL-21andDPL-21/Garima. Five significant and positive crosses, in order of ranking were Shubhra/DPL-21, Sweta/DPL-21, Sweta/KL-43, LMH-62/RLC-6 and DPL-21/Garima at Rath; Shubhra/J-23,DPL-21/J-23, Shubhra/Sweta,Sweta/LCK-88062 and Sweta / J-23 at Jabalpur; Shubhra / Garima, Sweta / LCK-88062, Sweta/KL-43, RLC-6 /LCK-88062 and Neelam/ DPL-21 at Kanpur; Sweta/KL-43, Shubhra/J-23, Sweta/ LCK-88062, Shubhra/Sweta and DPL-21/J-23 in pooled analysis.

Significant and positive heterosis over mid parent for this character was observed in 28,39,41 and 44 F_1 s with the range varied from-10.01 to 34.82, -16.73 to 108.09, 7.15 to 67.12, 7.79 to 50.05 percent at all the three locations and in pooled analysis, respectively. Twenty five cross combinations in F_1 revealed positive and significant heterosis over mid parent at all the three locations and pooled over locations. Where, cross Shubhra/Sweta ranked first followed by Sweta/KL-43, Shubhra/LCK-88062, Sweta/DPL-21 and Shubhra / DPL-21. Five significant and positive crosses revealing positive and significant heterosis over mid parent, in order of ranking were

Shubhra/DPL-21, Sweta/KL-43,LMH-62 /RLC-6, Neelam/RLC-6 and Sweta/DPL-21 at Rath; Shubhra/Sweta, Shubhra/J-23, DPL-21/LCK-88062, Shubhra/LCK–88062 and Sweta/J-23 at Jabalpur; Shubhra/Garima, Sweta /LCK-88062, Sweta/KL-43, Shubhra/LMH-62 and RLC-6/LCK-88062 at Kanpur and Shubhra/Sweta, Shubhra/J-23,Sweta/KL-43,Sweta/LCK-88062 and DPL-21/ J-23 in pooled analysis .

In F_2 generation, twenty one cross combinations revealed positive and significant inbreeding depression at all the three locations and in pooled analysis. Thirty five, 31, 38 and 37 F_2 s showed significant and positive inbreeding depression at Rath, Jabalpur, Kanpur and pooled over the locations, respectively. The range varied from-30.24 (Sweta/LMH-62) to 61 (Neelam/Sweta) percent at Rath; -23.44 (Shubhra/DPL-21) to 48.46 (Garima/LCK-88062) percent at Jabalpur; -21.24 (Sweta/J-23) to 35.02 (Sweta/LCK-88062) percent at Kanpur and –8.47 (Sweta/LMH-62) to 39.02 (Sweta/KL-43) percent on pooled basis. Five cross combinations in order of ranking in F_2 generation, recorded maximum significant and positive reduction namely, Neelam / Sweta, Neelam / RLC-6, Neelam / Shubhra, Shubhra/ Sweta and Sweta/KL-43 at Rath; Garima/LCK-88062, Neelam/KL-43, Sweta/LCK-88062, Sweta/KL-43andDPL-21/ RLC-6 at Jabalpur; Sweta / LCK-88062, Shubhra / Garima, Shubhra/J-23, J-23/RLC-6 and Sweta/KL-43 at Kanpur; Sweta/KL-43, Neelam/KL-43, Neelam/ Sweta ,Neelam/LMH-62 and Shubhra/Sweta in pooled analysis.

Heterosis over superior parent for number of seeds per capsules varied from –7.93 to 30.45 percent with 38 significant and positive crosses at Rath; -6.47 to 27.36 percent with 32 significant and positive crosses at Jabalpur; -13.44 to

29.13 percent with 37 significant and positive crosses at Kanpur and –9.44 to 23.98 percent with 36 crosses in pooled analysis. The maximum heterosis over superior parent was recorded in Sweta/KL-43 at all the locations and in pooled analysis as well followed by Sweta/DPL-21, Sweta/RLC-6, Shubhra/KL-43, DPL-21/RLC-6 and LMH-62/KL-43. Five cross combinations in order of merit recorded maximum and positive significant heterosis over superior parent were, Shubhra/ Sweta, Shubhra/KL-43, Sweta/DPL-21, Neelam/KL-43 and DPL-21/ KL-43 at Rath; Shubhra/ Sweta, Garima/ KL-43, Sweta/KL-43, Sweta/RLC-6 and Sweta/DPL-21 at Jabalpur; Sweta/KL-43, KL-43 / LCK-88062, J-23 / LCK-88062, LMH-62 / J-23 and DPL-21 / RLC-6 at Kanpur.

Fourty one crosses showing the range from—9.86 to 36.37 percent at Rath; -2.35 to 32.36 percent at Jabalpur; 39 crosses with the range from-10.03 to 34.12 percent at Kanpur and 43 crosses with the range from 0.79 to 27.42 percent in pooled analysis revealed significant and positive heterosis over mid parent. Thirty two cross combinations exhibited significant and positive heterosis over mid parent at all the locations and pooled over locations. Out of which crosses Sweta/KL-43 showed maximum heterosis followed by Sweta/RLC-6, Sweta/DPL-21, Shubhra/KL-43 and Neelam/KL-43. Five cross combinations exhibited significant and positive average heterosis, in order of preference were Shubhra/Sweta,Shubhra/KL-43,Neelam/KL-43, DPL-21/ KL-43 and Sweta/ DPL-21 at Rath; Shubhra/ Sweta, Sweta/ RLC-6,Sweta/ KL-43, Garima KL-43 and Sweta / DPL-21 at Jabalpur; Sweta/ KL-43, DPL-21/ J-23, J-23/ LCK-88062, LMH-62/J-23 and KL-43/ LCK-88062 at Kanpur and on pooled

basis were Sweta/ KL-43, Sweta/ RLC-6, DPL-21/ RLC-6, Sweta/ DPL-21 and Shubhra/ KL-43.

In F_2 s maximum depression was noted in 45 crosses at Rath (3.38 to 41.49 percent); 4 crosses at Jabalpur (-63.94 to13.54 percent); 39 crosses at Kanpur (-19.69 to 21.92 percent) and 25 crosses in pooled analysis (-16.38 to 20.52 percent). In order of ranking the highest depression was observed in four crosses such as Neelam/KL-43, Neelam/ Garima, DPL-21/RLC-6 and Neelam / RLC-6 at Rath; Neelam/ Garima, Neelam/J-23, Neelam/LMH-62 and Neelam /KL-43 at Jabalpur; DPL-21/RLC-6, Shubhra/RLC-6, LMH-62/J-23 and DPL-21/J-23 at Kanpur and Neelam/Garima, Neelam/J-23, Neelam/KL-43 and Neelam/LMH-62 in pooled analysis.

For thousand seed weight twenty six hybrids at Rath; 39 at Jabalpur; 20 at Kanpur and 36 on pooled over locations exhibited significant and positive heterosis over superior parent with the range from-18.23 to 24.31 percent at Rath; -9.88 to 31.58 percent at Jabalpur; 6.97 to 58.45 percent at Kanpur and from -4.91 to 24.47 percent in pooled analysis. Among these five significant and positive cross combinations, in order of ranking were Neelam/RLC-6, Shubhra / RLC-6, Shubhra/LCK-88062, RLC-6/LCK-88062 and Neelam/LCK-88062 at Rath; DPL-21/ KL-43, Shubhra/KL-43, DPL-21 / RLC-6, LMH-62/KL-43 and Sweta/RLC-6at Jabalpur; J-23/KL-43, LMH-62/KL-43, Sweta/ KL-43, LMH-62/Garima and Neelam/KL-43 at Kanpur and LMH-62/KL-43, DPL-21 /KL-43, J-23/KL-43, DPL-21/ Garima and Sweta/ KL-43 in pooled analysis.

Significant and positive average heterosis for thousand seed weight was observed in 26, 39, 20 and 36 F_1 s with the range from –11.83 to 31.35, -4.50 to 32.09, 7.50 to

617.8 and 2.88 to 205.77 at Rath, Jabalpur, Kanpur and in pooled analysis, respectively. Five significant and positive heterosis, in order of merit, were observed in crosses at Rath Sweta/KL-43, Sweta/Garima, Sweta/LCK-88062, Shubhra/ Sweta and DPL-21/KL-43; at Jabalpur Shubhra/RLC-6, DPL-21 /RLC-6, LMH-62/ RLC-6, Shubhra/ LCK-88062 and Sweta/ DPL-21; at Kanpur Sweta/LMH-62, Shubhra/Sweta, LMH-62/RLC-6,RLC-6/Garima andShubhra/LCK-88062 and on pooled basis these were Shubhra/Sweta,Sweta/KL-43,DPL-21/ KL-43, Shubhra/ RLC-6 and Shubhra/ LCK-88062.

In F_2s, 43 crosses revealed significant and positive depression ranging from –6.34 to 44.46 percent at Rath while at Jabalpur and Kanpur it was in 3 and 25 crosses ranging from -49.95 to 10.96 percent and 6.78 to 85.30 percent, respectively. Pooled estimates reflected that 21 crosses exhibited significant and positive inbreeding ranging from-12.49 to 21.60 percent. Two crosses namely Neelam/LCK-152 and Neelam/Sweta exhibited significant and positive depression at all the locations and pooled over locations. In order of merit the highest depression observed in five crosses at Rath were Neelam/ LCK-88062, Neelam/ RLC-6, Neelam/ J-23, Neelam/KL-43 and Neelam/Garima; three at Jabalpur were Neelam/LCK-88062, Neelam/Sweta, and Neelam/J-23; five at Kanpur were J-23/ KL-43, DPL-21/ Garima, RLC-6/ KL-43, Sweta/ KL-43 and RLC-6/ Garima and on pooled basis were Neelam/LCK-88062, Neelam/ DPL-21, Neelam/ J-23, Neelam/ Sweta and Neelam/RLC-6.

Heterosis over superior parent for harvest index varied from -14.24 to 51.31 percent with 31 significant and positive hybrids at Rath; -26.38 to 53.02 percent with 33

significant and positive hybrids at Jabalpur; -4.47 to 18.65 percent with 32 significant and positive hybrids at Kanpur and -8.47 to 30.79 percent with 32 significant and positive hybrids in pooled analysis. Cross Sweta/KL-43 was the common hybrid exhibiting significant and desirable heterosis over superior parent at all the locations and pooled over locations. Five best hybrids, giving significant and positive heterosis, were Sweta/KL-43, Sweta/Garima, DPL-21/KL-43, RLC-6/KL-43 and Sweta/LCK-88062 at Rath; Shubhra/RLC-6, DPL-21/ RLC-6, Sweta/ KL-43, Sweta/DPL-21 and Shubhra/Sweta at Jabalpur; DPL-21/KL-43, Neelam/LCK-88062, RLC-6/KL-43, Shubhra/ LMH-62and Sweta/LMH-62 at Kanpur and Sweta/KL-43, DPL-21/KL-43, Sweta/DPL-21, Shubhra/Sweta and DPL-21/ RLC-6 on pooled basis, in order of ranking.

Heterosis over mid parent for this character ranged from -3.99 to 56.76 percent with 38 significant and positive hybrids at Rath; -19.95 to 61.22 percent with 38 significant and positive hybrids at Jabalpur; 5.41 to 26.95 percent with 44 significant and positive hybrids at Kanpur and from 3.88 to 35.13 percent with 42 significant and positive hybrids on pooled basis. Out of 34 significant and positive combinations, cross Shubhra/Sweta revealed height significant and positive heterosis over mid parent at all the three locations and pooled over locations. Five other superior crosses revealing significant and positive heterosis over mid parent were Sweta/KL-43, Sweta/Garima, Sweta/LCK-88062, Shubhra/Sweta and DPL-21/KL-43 at Rath; Shubhra/RLC-6,DPL-21/RLC-6, LMH-62/ RLC-6,Shubhra/LCK-88062 and Shubhra/DPL-21 at Jabalpur; Sweta /LMH-62, Shubhra/Sweta,LMH-62/RLC-6, RLC-6/Garima and Shubhra/LCK-88062 at Kanpur and

Sweta/KL-43,LMH-62/ RLC-6, Shubhra /RLC-6,Shubhra/ LCK-88062 and Sweta/DPL-21 in pooled analysis in order of merit.

Twenty eight, 9, and 37 F_2 populations revealed significant and positive inbreeding depression at Rath, Jabalpur and Kanpur, respectively. Pooled estimates revealed significant and positive depression in 24 F_2 populations. The range of depression was –21.80 to 41.03 percent at Rath; -51.99 to 25.94 percent at Jabalpur; -8.91 to 46.06 percent at Kanpur and –16.14. to 25.58 percent in pooled analysis. The maximum reduction was observed in five crosses in order of ranking were Neelam/RLC-6, Neelam/Garima, Neelam/J-23, Neelam/Sweta and Neelam/LMH-62 at Rath; LMH-62/ RLC-6, Neelam/Garima, Neelam/LCK-88062, Neelam/LMH-62 and DPL-21/RLC-6 at Jabalpur; DPL-21 /Garima, J-23/KL-43, DPL-21 /KL-43, Shubhra/Sweta and Sweta/Garima at Kanpur and Neelam/Garima, Neelam/LMH-62, Neelam/ J-23, Neelam/LCK-88062 and DPL-21/KL-43 in pooled analysis.

In case of fibre yield per plant, the range of heterosis over superior parent varied from -71.50 to 399.26 percent with 29 significant and desirable hybrids at Rath; -48.15 to 244.35 percent with 31 significant and positive hybrids at Jabalpur; -43.63 to 41.50 percent with 43 significant and desirable hybrids at Kanpur and from -34.93 to 191.48 percent with 34 significant and desirable hybrids in pooled analysis. Twenty four cross combinations revealed positive and significant heterosis over superior parent out of which, in order of ranking, cross LMH-62/RLC-6 revealed maximum heterosis followed by Sweta/RLC-6, Shubhra/Garima, LMH-62/Garima, Shubhra/ LMH-62 and LMH-62/J-23 in pooled analysis over the locations.

In order of ranking five combinations at each location and pooled over locations were LMH-62/ RLC-6, Sweta/ RLCL-6 Sweta/ Garima, LMH-62/ Garima and Shubhra/ LMH-62 at Rath; Shubhra/ LMH-62, Sweta/ Garima, LMH-62/ Garima, LMH-62/ RLC-6 and Sweta/ RLC-6 at Jabalpur; Shubhra/ KL-43, Neelam/ KL-473, J-2.3/KL-43, Neelam/ LCK-88062 and RLC-6/ KL-43 at Kanpur and on pooled basis were LMH-62/RLC-6, Sweta/ RLC-6, Sweta/ Garima, LMH-62/ Garima and Shubhra/LMH-62.

Heterosis over mid parent revealed 37 significant and positive F_1 s at Rath with the range from -64.79 to 401.12 percent; 35 F_1 at Jabalpur with the range from –44.66 to 273.23 percent; 44 F_1 s at Kanpur with the range from -21.28 to 102.50 percent and 42 F_1s with the range from -28.99 to 200.03 in pooled analysis. Thirty three F_1s exhibited positive and significant heterosis over mid parent on pooled basis at all the three locations and pooled over locations. Out of which cross LMH-62/RLC-6 ranked first followed by Sweta/Garima, Sweta/RLC-6, Shubhra/LMH-62 and LMH-62/Garima. Five crop ranking crosses exhibiting positive and significant average heterosis were LMH-62/ RLC-6, Sweta/ RLC-6, Sweta/ Garima, LMH-62/ Garima and Shubhra/ LMH-62 at Rath; Shubhra/ LMH-62, Sweta/ Garima, LMH-62/ Garima, Sweta/ RLC-6 and LMH-62./ RLC-6 at Jabalpur; Shubhra/ KL-43m, Shubhra/ DPL-21, RLC-6/ KL-43, Shubhra/ LCK-88062 and J-23/ KL-43 at Kanpur and crosses LMH-62/ RLC-6, Sweta/ Garima, Swta/RLC-6, Shubhra/ LMH-62 and LMH-62/Garima on pooled basis.

In F_2s significant and positive inbreeding depression was noted in 27 crosses at Rath with the range from -327.58 to

73.97 percent; 24 at Jabalpur with the range from -207.46 to 79.09 percent; 44 at Kanpur with the range from – 62.65 to 73.25 percent and 36 on pooled basis with the range from-123.32 to 62.39 percent. The highest depression, in order of ranking, was observed in crosses such as Neelam/DPL-21, Neelam/Sweta, Neelam/LMH-62, LMH/DPL-21and LMH-62/ J-23atRath; Neelam /KL-43, Neelam/DPL-21, Sweta/Garima, LMH-62/DPL-21 and RLC-6/KL-43 at Jabalpur; Shubhra/ DPL-21, DPL-21/Garima, DPL-21/RLC-6, Sweta/DPL-21 and Garima/ LCK -88062 at Kanpur and LMH-62/DPL-21, Neelam/DPL-21, Neelam/Sweta, Neelam/Garima and Neelam/ KL-43 in pooled analysis.

Seventeen hybrids at Rath; 19 at Jabalpur 31 at Kanpur and 23 in pooled analysis revealed significant and positive heterosis over superior parent for oil content. The range of heterosis varied from-3.23 to 4.63 percent at Rath; -5.49 to 5.27 percent at Jabalpur; -0.89 to 4.85 percent at Kanpur and – 1.89 to 3.04 percent in pooled analysis. Ten hybrids revealed significant and positive heterosis over superior parent at all the three locations and pooled over locations. Out of which cross DPL-21 / J-23 revealed maximum significant and positive heterosis over superior parent followed by Garima/LCK-88062, DPL-21/LCK-88062, Neelam/Garima and Neelam/ LCK-88062. Five crosses namely Sweta/Garima, Sweta/LCK-88062, Neelam/Garima, Garima/LCK-88062 and DPL-21/ LCK-88062 revealed positive and significant heterosis over superior parent at Rath; Shubhra /J-23, DPL-21/J-23, Shubhra/LCK-88062, DPL-21/Garima and Garima/LCK-88062 at Jabalpur; Sweta/ DPL-21 , Sweta/LCK-88062, DPL-21/RLC-6, Sweta/J-23 and DPL-21/LCK-88062 at Kanpur and DPL-21/ J-23, Sweta/

LCK-88062, Garima/LCK-88062, DPL-21/Garima and Neelam/ Garima in pooled analysis.

Significant and desirable heterosis over mid parent was observed in 32 F_1 s with the range from-2.33 to 6.59 percent at Rath; 30 F_1 s with the range from -4.85 to 6.71 percent at Jabalpur; 43 F_1 s with the range from 0.64 to 6.79 at Kanpur and 39 F_1 s with the range from 0.86 to 4.98 in pooled analysis. Out of above significant and positive crosses five crosses at each location in order of ranking, were Sweta/Garima, Shubhra/J-23, Sweta/LCK-88062, Shubhra/Garima and Shubhra/LCK-88062 at Rath; Shubhra/LCK-88062, Shubhra/J-23, DPL-21/J-23, Neelam/LMH-62 and Neelam/Sweta at Jabalpur; DPL-21/ RLC-6,Sweta/DPL-21,Sweta/J-23, J-23/RLC-6 and LCK-88062/ DPL-21at Kanpur and Shubhra/J-23,Sweta/J-23, Neelam/ LMH-62, DPL-21/J-23 and Sweta/LCK-88062 at all the three locations and pooled over locations in order of ranking.

In F_2, 32 crosses at Rath showing the range from -3.70 to 8.86 percent, 13 crosses with the range from –8.20 to 6.75 percent at Jabalpur, 42 crosses with the range from 0.65 to 7.99 percent at Kanpur and 35 crosses with the range from -2.75 to 5.75 percent in pooled analysis revealed significant reduction in vigour. The maximum significant depression, in order of merit, in case of five crosses namely, Neelam /Shubhra, RLC-6 /LCK-88062, Sweta /LCK-88062, Garima /LCK -88062 and Shubhra / LCK-88062 at Rath; Shubhra / J- 23, Neelam / RLC- 6, RLC-6 / LCK - 88062, Neelam /Shubhra and DPL-21 / J-23 at Jabalpur and DPL-21 / RLC-6, J-23 /RLC-6, Sweta/ J-23 , Sweta /DPL-21 and LMH-62 /J-23 at Kanpur and Shubhra/J-23, RLC-6/LCK-88062, Neelam/Shubhra, Sweta/ LCK-88062 and Neelam /RLC-6 on pooled basis were recorded.

In case of seed yield per plant, the range of heterosis over superior parent varied from -43.22 to 145.93 percent with 26 significant and desirable hybrids at Rath; -29.60 to 58.19 percent with 31 significant and desirable hybrids at Jabalpur; -4.62 to 49.11 percent with 40 significant and desirable hybrids at Kanpur and –20.58 to 68.75 percent with 29 significant and desirable hybrids in pooled analysis. Amongst the 23 hybrids Sweta/DPL-21 exhibited maximum significant and desirable heterosis over superior parent at all the locations and pooled over locations followed by Shubhra/Sweta, Sweta/KL-43, Shubhra/RLC-6, DPL-21/KL-43, DPL-21/ RLC-6, Sweta/ LCK-88062, Shubhra/J-23, Neelam/RLC-6 and DPL-21/J-23. Five best hybrids giving significant and positive heterosis over superior parent were, Sweta/DPL-21,Shubhra /J-23,Sweta/ KL-43, Shubhra/Sweta and Shubhra/RLC-6 at Rath; Shubhra/ J-23, Shubhra/RLC-6, Sweta/Garima, DPL-21/KL-43 and Shubhra/Sweta at Jabalpur and Neelam/RLC-6, DPL-21/J-23, Sweta/DPL-21, LMH-62/DPL-21 and Shubhra/ J-23 at Kanpur.

Thirty seven, 38 and 45 F_1 s revealed significant and desirable heterosis over mid parent at Rath, Jabalpur and Kanpur, respectively. Pooled estimates revealed significant and desirable heterosis over mid parents in 42 crosses. The range of heterosis over mid parent was from –36.53 to 187.89 percent at Rath; -18.66 to 83.61 percent at Jabalpur; 3.27 to 74.15 percent at Kanpur and from -10.09 to 100.75 in pooled analysis. Thirty three crosses revealed significant and desirable heterosis over mid parent at all the three locations and pooled over locations. Cross Shubhra/Sweta revealed maximum heterosis over mid parent at all the three locations and pooled over locations. In order of ranking five superior combinations were

Shubhra/Sweta,Sweta/DPL-21, Sweta/KL-43, Sweta/RLC-6 and Sweta /LCK-88062 at Rath; Shubhra/ Sweta, Shubhra/ RLC-6, Shubhra/LCK-88062, Sweta/KL-43 and Neelam /LMH-62 at Jabalpur; LMH-62 /DPL-21, Neelam/RLC-6, DPL-21/ J-23, Sweta/LMH-62 and Shubhra/RLC-6 at Kanpur and Sweta/ KL-43, Sweta/LCK-88062, Shubhra/RLC-6, DPL-21/ KL-43 and DPL-21 / RLC-6 in pooled analysis.

In F_2 generation, 31 F_2 s at Rath, 18 F_2 s at Jabalpur, 39 F_2 s at Kanpur and 29 F_2 s in pooled analysis showed significant positive depression with the range varied from –67.35 to 52 percent at Rath; -86.84 to 51.26 percent at Jabalpur; -20.19 to 41.79 percent at Kanpur and –35.92 to 37.84 percent in pooled analysis. The maximum reduction was observed in five crosses in order of ranking and these were, Neelam/LMH-62, Garima/LCK-88062, Shubhra/ Sweta, Sweta/LCK-88062 and Neelam/Sweta at Rath; Neelam/LMH-62, DPL-21/J-23, Neelam/Garima, Neelam/J-23 and Shubhra/LCK-88062 at Jabalpur; DPL-21/ Garima, LMH-62 /DPL-21, LMH-62/KL-43, RLC-6/ Garima and DPL-21/ LCK-88062 at Kanpur. Fourteen crosses revealed significant and positive reduction at all the three locations and pooled over locations, out of which five crosses in order of ranking were Neelam/LMH-62, Shubhra/Sweta, DPL-21/J-23, LMH-62/RLC-6 and Sweta/ LCK-88062.

STABILITY ANALYSIS:

Stability analysis was worked out on the basis of lines advocated by Eberhart and Russell (1966) for all the 13 characters in F_2 generation including 10 parents involved in

crossing. The analysis of variance for stability parameters is furnished in table 11.

The ~~observations~~ perusal of table 11 indicates highly significant differences among the genotypes (Parents and F_2s) for all the 13 characteristics. Highly significant differences were recorded among the environments .The genotypes intercepted strongly with environments (G×E) for all the characters indicating highly significant values. The environment (linear) reflected highly significant differences in all the characters in this study.

The non-linear components (Pooled deviation) exhibited highly significant differences for all the characters. For evaluating the stability parameters ($\bar{x}$, b_i and s^2d_i) of individual genotype (10 parents and 45 F_2s) in respect of 13 attributes were determined and results are presented in Table.12.

Regression coefficient (bi) was found to be significant in case of one parent and seven F_2s for days to 50% flowering. Deviation from non-linear regression (s^2d_i) was significant in case of 9 parents and 29 F_2 s .A simultaneous consideration of both the stability parameters for individual combination in F_2 was observed in the crosses Shubhra /LMH-62, Neelam/LMH-62 and in LMH-62 /RLC-6 for the character.

The test of two stability parameters (b_i) and (s^2d_i) in case of days to maturity showed significant linear portion for 3 parents and 13 F_2s while non-linear component was found to be significant in 7 parents and in 31 F_2s. Parent Garima was found to be stable because (b_i) value was near to unity, s^2d_i was not significant and mean value was less than population mean which was desirable. Two F_2s namely, Sweta/LMH-62 and J-23/RLC-6 were found to be stable combinations when all the

three stability parameters were taken into consideration at a time.

Non of the parents and F_2s revealed significant differences for (b_i) while non-linear (s^2d_i) indicated significant differences in 4 parents and 17 F_2s for plant height. Parent J-23 and 8 F_2 cross combinations namely, LMH-62/Garima, Sweta/LMH-62, RLC-6/ Garima, Sweta/ Garima, J-23/RLC-6, Sweta/J-23, Sweta/RLC-6 and LMH-62/ J-23 were considered stable combinations when three parameters ($\bar{x}$, b_i and s^2d_i) of stability were accounted for together.

In case of technical plant height, non of the parents showed significant b_i value while it was significant in two F_2 progenies. Component s^2d_i was significant in case of eight parents and 24 F_2 populations. Parent Neelam was found to be stable for the character as regression coefficient was near to unity and non-linear deviation was not significant. Seven crosses in F_2s,LMH-62/DPL-21,Garima/LCK-88062,LMH62/LCK-88062, Shubhra / LCK-88062, RLC-6 / KL-43, Neelam / Garimaand Neelam/J-23 were observed stable combinations when all the parameters were considered together.

Absence of significant b_i value was recorded in case of parents with respect to number of tillers per plant. However, 12 F_2 s revealed significant values. Significant s^2d_i values were recorded in 6 parents and in 28 F_2 s. Parent Garima indicated near to unity as regression coefficient and non-significant value of s^2d_i reflected stability in this parent though the mean value was lower than the population mean value. Considering all the three parameters of stability at a time, DPL-21 / KL-43 was found to be stable.

In case of number of branches per plant significant b_i values were found in two parents and 35 F_2s. Significant s^2d_i values were found in 5 parents and the same was observed in 19 F_2 generations. The parent LMH-62 revealed stability for the character as regression coefficient was near to unity and non-linear deviation was not significant. Seven F_2 combinations namely, Shubhra/LMH-62, LMH-62/RLC-6, LMH-62 /DPL-21, J-23 /Garima, Neelam/ LMH-62, LMH-62/KL-43 and Neelam/ Shubhra showed stable performance in respect of this character.

For number of capsules per plant regression coefficient was significant in 4 parents and in 20 F_2 combinations, while deviation from non-linear regression (s^2d_i) was significant in 6 parents and 28 F_2s. When all the three parameters were considered, 10 cross combinations in F_2 namely,LMH-62/Garima, Neelam/LMH-62, LMH-62/LCK-88062, Sweta/LCK-88062, DPL-21/Garima, DPL-21/J-23, Shubhra/ Sweta, J-23/LCK-88062, Sweta/DPL-21 and Sweta/RLC-6 revealed stable performance. Parent Sweta revealed stable performance as bi value was near to unity and non-significant value of s^2d_i was observed.

Regression coefficient was significant in 6 parents and 36 F_2 s for number of seeds per capsule, while deviation from non-linear regression (s^2d_i) was significant in 2 parents and in 19 F_2 combinations. Considering all the three parameters for each genotype, parent Neelam and 8 F_2 s (Neelam/J-23, Neelam/KL-43, Neelam/LCK-88062, Neelam/Garima, Neelam/ Sweta,Sweta/Garima,LMH-62/LCK-88062 and Neelam/LMH-62 showed stable performance in respect of this character.

Absence of significant b_i and s^2d_i value were recorded for parents in case of 1000 seed weight. Significant bi and s^2d_i

values were recorded for only one F_2 combination. Parents Neelam and Sweta and 12 F_2 expressed stability over the locations. Among them 7 combinations namely Sweta/KL-43, Neelam/LCK-88062, Garima/ LCK-88062, Neelam/RLC-6, Sweta/J-23, Neelam/Sweta and Neelam/ DPL-21 revealed maximum stability in respect of this character.

Regression coefficient was found significant in four parents and in 7 F_2 progenies for harvest index, while deviation from non-linear regression was significant for two parents and 14 F_2s. Parents LCK-88062 and Neelam revealed b_i value near to unity and non-significant s^2d_i value showing stability for this character. Out of eleven F_2 combinations seven combinations (Sweta/LMH-62, LMH-62/J-23, LMH-62/Garima, Neelam/ Garima, Neelam/LCK-88062, Sweta/Garima and Garima/ LCK-88062) were found to be stable when $\bar{x}$, bi and s^2d_i parameters were considered together.

Absence of significant b_i values were recorded for parents in case of fibre yield per plant. However, 7 F_2 s revealed significant differences. Significant s^2d_i was recorded for 3 parents and 32 F_2s. Parents LCK-88062, Neelam and F_2 cross combinations namely LMH-62/DPL-21,DPL-21/KL-43,LMH-62/ LCK-88062 and Garima/ KL-43 were found to be stable when all the three stability parameters were taken in to account.

In case of oil content, the linear component, and pooled deviation (non-linear) revealed significant differences for 3 parents each while in F_2 progenies b_i values were found significant in 14 F_2 s and s^2d_i values in 31 F_2 generations. Three parents (RLC-6, Sweta and KL-43) and seven F_2s (Sweta/ LMH-62, Shubhra/Sweta, LMH-62/LCK-88062, RLC-6/ KL-43, Sweta/ KL-43, J-23 /KL-43 and Garima/ KL-43) were found to

be stable when $\bar{x}$, b_i and s^2d_i parameters were considered together.

Significant regression coefficient was observed for two parents and 3 F_2s for seed yield per plant, while deviation from non-linear regression was significant for 5 parents and 32 F_2s. Parent LMH-62, in order of ranking, based on higher mean performance as compared to population mean was found to be stable, due to non -significant s^2d_i and b_i near to unity. Six F_2s (LMH-62/ Garima, RLC-6 / Garima, Sweta/ Garima, RLC-6/ LCK-88062, Garima/ LCK-88062 and DPL-21/ LCK-88062) seemed to be stable when all the three parameters for stability were considered simultaneously.

HERITABILITY:

Heritability estimates were worked out on the basis of genetic components (narrow-sense) with regard to all 13 attributes under study separately for all the three locations and pooled over the locations in both F_1 and F_2 generations. Results of heritability are ~~attributed~~ in table 13.

The values of heritability were usually arbitrarily but reasonably it was categoriesed as per norm prescribed by Robinson (1966) into three distinct classes such as high heritability (above 30 percent), moderate heritability (above 10 and below 30 percent) and low heritability (below 10 percent) in narrow- sense.

The observations of table 13 marked high heritability estimates for days to 50% flowering, oil content in both the generations at all the three locations and on pooled basis except fibre yield and plant height in case of F_1 at Kanpur location. Table 13 revealed high heritability estimates for days to maturity

in case of F_1 at all the locations and pooled over locations; technical plant height in both the generations at Rath and plant height in both the generations at Rath and in F_2 at Kanpur and on pooled basis also; number of tillers per plant in F_2 at Rath, in F_1 at Jabalpur and in pooled analysis; number of capsules per plant in F_2 at Rath and Jabalpur; number of seeds per capsule in F_2 at Jabalpur, Kanpur and in pooled analysis; 1000 seed weight in both the generations at Rath and in F_2 for pooled analysis; harvest index and seed yield per plant in both the generations at Rath and in pooled analysis; harvest index in F_2 generation at Jabalpur and in F_1 at Kanpur; seed yield per plant in F_2 at Jabalpur and Kanpur. Moderate values were observed for days to maturity in F_2 at Rath, Kanpur and in pooled analysis; technical plant height in both the generations at Jabalpur and in F_1 at Kanpur and on pooled basis; number of tillers per plant at Kanpur in both the generations, in F_1 at Rath and in F_2 on pooled basis; number of branches per plant in both the generations at Kanpur and in pooled analysis; number of capsules per plant in F_1 at Rath, Jabalpur and in F_2 at Kanpur and in pooled analysis; number of seeds per capsule in F_1 at Jabalpur and in pooled analysis but in F_2 at Rath;1000seed weight in both the generations at Jabalpur and in F_2 at Kanpur; harvest index in F_1 at Jabalpur and in F_2 at Kanpur; seed yield per plant in F_1 at Jabalpur and Kanpur.

GENETIC ADVANCE:

Genetic gain calculated as genetic advance in percent of mean in both the generations with regard to all the 13 characters and all the locations and pooled over the locations. The estimates are furnished in table 14.

It was quite obvious from table 14 that genetic gain was found to be high in F_1 and F_2 for fibre yield per plant; in F_2 for seed yield per plant at all the three locations and in F_1 at Rath. It was high for days to 50% flowering at Kanpur in F_1; plant height at Rath and Jabalpur in F_1; technical plant height at Rath and Kanpur in F_2; number of capsules per plant at Kanpur in F_1 and seed yield per plant at Rath in F_1. While moderate values were observed for days to 50% flowering in both the generations at Rath; Jabalpur and in F_2 at Kanpur; plant height in both the generations at Rath, in F_1 at Jabalpur and in F_2 at Kanpur; technical plant height in F_1 at Rath and Kanpur; number of tillers per plant in both the generations at Rath, in F_1 at Jabalpur and Kanpur; number of capsules per plant in both the generations at Jabalpur and in F_2 at Rath; number of seeds per capsules in both the generations at Jabalpur; 1000 seed weight in both the generations at Rath and in F_1 at Kanpur; harvest index in both the generations at Rath, in F_1 at Kanpur and in F_2 at Jabalpur and seed yield per plant in F_1 at Jabalpur and Kanpur.

Pooled estimates on genetic gain reflected high values for both the generations for days to 50% flowering, plant height, fibre yield per plant and seed yield per plant; technical plant height in F_2; number of tillers per plant in F_1. While moderate gain was observed to be in respect of harvest index in both the generations; days to maturity and technical plant height in F_1; number of tillers per plant, number of branches per plant, number of capsules per plant, number of seeds per capsules and 1000 seed weight in F_2. Remaining attributes in both the generations and in pooled analysis showed low genetic gain.

Chapter-V

RESULT AND DISCUSSION

DISCUSSION

The main objective of a plant breeding programme is to develop superior strains/cultivars in yield and other desired characters. Hence, exploitation of genetic variability which is generated in self pollinated species like linseed with the help of selection, hybridization, mutation and so on. Genetic variability is imperative and vital tool for a plant breeder to develop varieties which should have maximum potential of yield in order to catter the need of rapidly growing population for the country like India. For evaluation of superior strain in comparison to exhisting ones, the skillful manipulation of the germplasm is essentially felt so as to incorporate favourable genes in recombinants for various ecological conditions. Considering these aspect in mind, the present investigation has been designed to have precise and accurate knowledge with regard to genetic architecture of quantitative attributes including seed yield and quality characters pertaining to productivity in this oil seed crop.

Linseed ~~crop~~ breeding programme is similar to other self-fertilized species, which need careful handling of the genetic variation for the development of new genotypes possessing desirable traits including seed yield. Undoubtedly, the population yield and vigour are the essential need to run any crop improvement programme with great success. Consequently, plant breeders should made efforts to explore the potential desirable genes contributing maximum return in terms of yield.

Yield i.e. grain yield, oil yield, fibre yield, quality yield and so on, is the complex multigenic group of characters depending

on genetic, physio-morphological, ecological and ~~pathological~~ interceptions. The inherent potential of a cultivar/genotype depends upon its stability for yield security. Genetically yield contributing characters are known as yield components for example, number of tillers per plant, number of branches per plant, 1000 seed weight, etc., their genetic nature and magnitude of stability in these attributes are responsible for realization of good harvest affected by changing edaphic and agro-climatic conditions. The information on these aspects is needed to resolve and quantify their mode of contribution to grain yield through biometrical approaches like diallel mating design.

Much progress has been made in the middle of the twentieth century to develop the procedures for analysis of quantitative characters. Biometrical techniques for cross prediction are based on the principles defined by Mather (1949), Mather and Jinks (1971,1982) based on generation mean analysis and Griffing (1956a, 1956b) for prediction of the parents and their cross combinations in single environment and Singh (1973 and 1979) advocated to work out such prediction in a number of environments in early generations by means of diallel and modified diallel mating design and also over the locations to adjudge their stability performance based on Eberhart and Russell›s (1966) model.

Diallel cross mating is based on seven assumptions (Hayman, 1954) and their validity in linseed may be discussed as:

(a) Homozygous parents: Cultivated linseed (Linum usitatissimum L.) is diploid with 2n=30 chromosomes and self-

fertilized species and all the varieties / strains used in the present study were diploid, hence homozygous at all the loci.

(b) Normal diploid segregation: In case of linseed, the established fact is due to the presence of 2n chromosome number.

(c) No reciprocal differences : It is not reported in linseed for seed yield component and iodine value (Rai, 1973) and did not play any significant role.

(d) No multiple alleles and no linkage: It is rather difficult to satisfy.

(e) Absence of Epistasis: The non -allelic gene interaction might be removed through changing over to some other scale as proposed by Hayman (1957).

(f) Uncorrelated distribution: It is also difficult to satisfy as in most of the other crops (Kempthorne, 1956).

Limitations of diallel cross techniques were attributed by Hayman (1954) and it was critically examined by Kempthorne (1956), Gilbert (1958), Cockerham (1959) and Nassar (1965).They pointed out that ~~much~~ such genetic assumptions as absence of epistasis and lack of multiple alleles are only made in order to obtain a simple working hypothesis and they further observed that data are made to fit in the hypothesis and the assumption of independent distribution of genes in parents is rather difficult except in the trivial cases. Hayman (1954,a) suggested that the removal of arrays one by one facilitated to pin point the parent (s)which contributed to most epistatic effects. However, Kempthorne (1956) and Gilbert (1958) objected it and they conducted that results based on such selective analysis could not have wide inductive application. On the other hand, Wright and Robinson (C.F., Haryman, 1963) indicated

the difficulties in getting random sample of lines but felt the elimination of arrays was justifiable only when particular set of lines was to be studied.

Inspite of limitations of the diallel cross, several plant breeders have reported some usefull insight into the inheritance of the relatively complex traits which are obtained even in case of these assumptions are not fully satisfied. Thus, in the present investigation, diallel cross mating technique using of appropriate number of parents was used to collect the genetic information in linseed. As a result, 10 varieties/ genotypes were studied on the basis of their suitability under different conditions using over the locations and 45 straight single crosses were developed and studied.

COMPONENTS OF VARIATION AND GENETIC VARIANCES:

The understanding of variation and genetic architecture of population and system into which the genes are operating, is of great importance for application of systematic and effective breeding procedures. Significant and usefulness of the characterization of variation and genetic architecture of breeding population into the improvement of crop plants have been demonstrated in maize which is based on the nature of gene action and thus one or the other forms of heterotic breeding or recurrent selection or synthetic or composite breeding approaches have been advocated. Similar approaches with suitable adjustment could be applied in the improvement of the autogamous crops (Hanson, 1959, Gilmose 1964; Jensen, 1970; Meredith and Bridge, 1971, Gill et al. 1973; Redden and Jensen, 1974; Sahu 1980; Dwivedi and

Singh, 1980; Singh, 1981; Singh et al 1984; Gill et al., 1984 and Balyan 1984).

The higher estimates of variability for the characters, technical plant height followed by plant height, number of capsules per plant, days to 50% flowering, days to maturity, number of branches per plant, harvest index, seed yield per plant, number of tillers per plant, oil content, fibre yield per plant, 1000 seed weight and number of seeds per capsule in both the generations and on pooled over locations indicated that selection would be more effective for these characters in increasing production. Jagdev (1990) reported high variability for harvest index (24.5 to 46.1) but was lower for economic yield (1.07 to 2.93). Ermakov (1965) studied the oil content in 280 varieties of flax and reported the range of 34.3 to 45.4 percent in different varieties. A variation of 38.3 to 45.3 percent was reported by Sekhon et al. (1973). Mark and Rosenberg (1976) found a range of variation from 37.3 to 46.2 percent and moderate to high variability in case of iodine value was observed by Varbov (1966), Sekhon et al. (1984), Bajpai et al. (1985) and Yadav (1998) found a range of variation from 39.53 to 45.65 percent in case of oil content.

The genetic components of variance for all the 13 characters were estimated using "diallel " mating design with two approaches (i) genetic components (ii) combining ability. The analysis revealed significant value for additive genetic component ($\hat{D}$) at all the locations in both the generations for days to 50% flowering plant height, number of capsules per plant, fibre yield per plant, oil content and seed yield per plant whereas, it was significant for days to maturity at all the three locations in F_2

except at Jabalpur; for technical plant height except in F_1 at Jabalpur and Kanpur; for number of tillers per plant in F_2, for number of branches per plant except at Rath and Jabalpur in both the generations; for 1000 seed weight except at Kanpur in F_1 generation and in F_2 generation for harvest index. The dominant components ($\hat{H}_1$ and $\hat{H}_2$) indicated highly significant and positive value for days to 50% flowering, number of capsules per plant, number of seeds per capsule, fibre yield per plant, oil content and seed yield per plant in both the generations and at all the three locations. Non–significant value was observed for both the dominance components for days to maturity at Jabalpur in F_2, number of tillers per plant in F_2 generation at Jabalpur and Kanpur, number of branches per plant and harvest index at Kanpur in F_2 and in F_1 generation for 1000 seed weight at Kanpur. Non-significant magnitude of $\hat{H}_1$ component was observed for technical plant height in F_2 at Kanpur whereas H_2 component was non-significant for plant height at Jabalpur in F_1 generation. The estimates of $\hat{D}$, $\hat{H}_1$ and $\hat{H}_2$ components and average degree of dominance showed that the relative magnitude of dominance genetic component was greater than that of additive component for ten out of thirteen characters.

The combining ability study revealed significant contribution of both the additive and non-additive components of genetic variances for all the characters. The estimate of $\hat{\sigma^2 g}$ and $\hat{\sigma^2 s}$ exhibited that the relative contribution of non-additive genetic component was higher than that of additive component in direct yield contributing traits like number of tillers per plant, number of branches per plant, number of capsules per plant, number of seeds

per capsule, 1000 seed weight and harvest index. The estimates of expected mean squares of SCA variances were greater than GCA variances in these characters. General predictability ratio (GPR) was observed less than one in all the characters. It was maximum for plant height, days to 50% flowering, harvest index, fibre yield per plant, oil content and days to maturity. In rest of the attributes, substantial amount of additive genetic variance was also present.

Both diallel analysis and component analysis had shown significant contribution of additive and non-additive genetic variances for more than 90 percent of the characters under study. However, magnitude in these estimates varied from one approach to another approach and character to character. Such differences in both the approaches were due to nature and magnitude of genetic variances. Many contradictory information based on diallel, partial diallel, line × tester, generation means and TTC analysis have been witnessed. Some linseed workers have observed predominance of additive gene effects for days to flowering (Joshi et al. 1961; Anand et al. 1972; Mishra, 1977; Kumar et al. 1980 Patel et al. 1997; and Yadav, 1997) for days to maturity (Singh, 1977; Singh et al. 1987; Patel, et al. 1997; and Yadav 1997) for plant height (Anand et al. 1972; Mishra, 1977; Sharma, 1986; Patel et al. 1997; Yadav, 1997 and Mahto and Rahman, 1998); for number of tillers per plant (Singh, 1997); for number branches per plant (Singh 1997, Rao and Singh, 1982 and Singh et al. 1987) for number of capsules per plant (Sharma, 1986; Khorgade et al.1992; Patel et al 1997 and Yadav 1999); for number seeds per capsule (Mishra,1977; Rao and Singh, 1984 and patel et al 1997); for thousand seed weight (Singh, 1977; Doucet, 1978; Rao and Singh,

1984; Sharma, 1986; Singh, 1987; Yadav, 1997 and Mahto and Rahman 1998); for oil content (Doucet and Filipescu, 1981 and Yadav, 1997); and for seed yield per plant (Murty and Anand, 1966; Murty et al. 1967; Patil and Chopade 1981; Kumar and Chauhan, 1982; Rao and Singh, 1987; Sharma, 1986; Rao and Singh, 1987; Tak and Gupta, 1987; Khrogade et al. 1992; Patel et al. 1997; Goray et al. 1997 and Yadav, 1997). On the other hand, predominance of non-additive gene effects were observed for days to maturity (Mishra, 1977; Rao and Singh, 1984 and Singh, 1984); for number of branches per plant (Mishra, 1977 and Singh, 1977); for number of seeds per capsule (Singh 1977); for plant height (Rao and Singh, 1984); for 1000 seed weight (Mishra, 1977); for oil content (Mishra, 1977; Singh, 1977; Tak, 1987 and Khorgade, 1997), for fibre yield (Khorgade, 1992) and for seed yield per plant (Mishra, 1997; Singh 1977 and Tak, 1984 and Khorgade, 1992).

Consistency for over dominance was recorded for technical plant height, number of tillers per plant, number of capsules per plant, fibre yield per plant, oil content and seed yield per plant which might be due to linkage or changed environment. Over dominance also appears due to non-allelic interaction as reported by Mather (1955). Over dominance gene action was reported by Anand et al. (1972), Mishra (1977), Doucet (1978), Singh and Singh (1979), Bhatnagar and Mehrotra (1980), Kumar and Chauhan (1982), Rao and Singh (1986), Singh and Dixit (1988), Tak and Gupta (1989), Mishra (1990), Rai et al. (1990), Khorgade et al. (1994), Mukul et al. (1994), Sukhovich (1999) and Yadav (1999).

The positive and significant values of $\hat{F}$ component was recorded for oil content at Rath in F_1 generation whereas for technical plant height and harvest index at Rath; for number of seeds per capsule and seed yield per plant at Jabalpur and for seed yield per plant at Kanpur, these were positive and significant in F_2 generation. Fibre yield per plant revealed significant and positive value of $\hat{F}$ component in F_2 generation but it showed negative value in F_1 generation indicating that the distribution of dominant genes was more frequent than the recessive genes in the parents. Yadav (1999) reported similar findings for most of the above mentioned characters.

The value of $\hat{h}^2$ was noted as positive and significant for plant height; technical plant height, number of branches per plant, numbers of capsules per plant, number of seeds per capsule, harvest index, fibre yield per plant, oil content and seed yield per plant in F_1 at all the three locations which revealed the preponderance of dominant genes in consistent nature. The finding of Anand et al. (1972) and Yadav (1997) were similar to most of the characters.

The mean degree of dominance $(\hat{H}_1/\hat{D})^{0.5}$ was observed to be higher than unity for technical plant height, number of tillers per plant, number of branches per plant, number of capsules per plant, harvest index, 1000 seed weight, fibre yield per plant, oil content and seed yield per plant in both the generations at all the locations indicating prevalence of over dominance for above characters. Partial dominance was observed for days to 50% flowering in F_1 generation at Rath and Kanpur. Plant height showed over dominance in both the generations at Kanpur and in F_2 at

Rath. Similar observation was recorded for days to 50% flowering in F_2 at all the locations and in F_1 at Jabalpur, for days to maturity in F_2 at all the locations and in F_1 at Kanpur.

Significant and positive estimates of $\hat{E}$ component were reported for harvest index in both the generations at all the three locations, plant height in both the generations at Rath and Jabalpur, number of capsules per plant in both the generations at Rath and Kanpur, number of tillers per plant in F_2 at Jabalpur and Kanpur, number of branches per plant in both the generations at Kanpur and in F_2 at Jabalpur, number of seeds per capsule in F_1 and F_2 at Kanpur and Rath, respectively, 1000 seed weight and oil content in both the generations at Jabalpur and oil content in F_2 generation at Rath reflecting substantial degree of environmental effects in the expression of these characters. These results were in accordance with the reports of Yadav (1997) for plant height .

The ratio of $(\hat{H}_2/4\hat{H}_1)$ was less than the theoretical value for all the 13 traits in F_1 and F_2 at all the locations showing asymmetrical distribution of favourable and unfavourable genes among the parents. It indicated that the distribution of loci among the parents was not in balancing form in respects of all the attributes. These results are supported by earlier reports of Anand et al. (1972) and Yadav (1997).

The value of KD/KR was observed more than one in both the generations at all the three locations for number of seeds per capsule, 1000 seed weight, oil content and seed yield per plant. The preponderance of dominant alleles was confirmed by positive values of F components in these characters.

The ratio of dominant and recessive alleles among the parents is determined to the extent of genetic advance which can be estimated in a population. The proportion of dominant genes was fairly moderate for most of the characters except few as mentioned in findings which effected moderate amount of genetic gain in yield contributing characters. These findings are in agreement with those of Anand et al. (1972); Wicks (1980) and Sharma (1986).

The ratio of $\hat{h}^2 / \hat{H}_2$ may also be less due to the action of complementary genes interaction therefore, the number of group of genes reported may be higher/ lower than the actual numbers involved. Most of the characters under study in both the generations and over the locations were controlled by one pair of gene group. Anand et al. (1972) reported that morphological traits were controlled by one pair of major genes with no modifiers..

The correlation between parental order of dominance and parental measurement was found to be negative for number of tillers per plant, number of capsules per plant, 1000 seed weight, harvest index, fibre yield per plant, oil content and seed yield in F_1 at all the three locations; days to 50% flowering in both the generations at Rath, in F_2 at Kanpur and in F_1 at Jabalpur; days to maturity in F_2 at all the three locations; plant height in both the generations at Rath and Jabalpur; and in F_2 at Jabalpur; technical plant height in F_1 at Rath and in F_2 at Jabalpur and Kanpur; number of tillers per plant and 1000 seed weight in F_2 at Jabalpur and at Kanpur; number of branches per plant in both the generations at Rath and at Kanpur in F_1; number of seeds per capsule in F_1 at Rath and Jabalpur; harvest index and seed yield

per plant in F_2 at Jabalpur showing that positive genes were responsible to express these characters and were dominant in nature. Rest of the characters in their respective generations and locations expressed negative effects of genes.

The major interest in the present study is to see its implication on the nature of gene effects in a group of highly selected material and in formulation of a suitable breeding programme in linseed. Matzinger and Kempthorne (1956) advocated that the estimates of genetic components ($\sigma^2\hat{g}$ and $\sigma^2\hat{s}$) from a diallel set of crosses of parents, related to variance of population from which parental lines were taken as a sample, are more beneficial. The sizeable magnitude of estimation of $\sigma^2\hat{g}$ in the present material showed that a major portion of genetic variance in the base population was non-additive in days to 50% flowering, days to maturity, technical plant height, number of branches per plant, number of capsules per plant and seed yield per plant in both the generations whereas plant height, number of tillers per plant, 1000 seed weight, harvest index, fibre yield per plant and oil content in F_1 generation.

The importance of genotype×environment interaction was reported in many crops and ommission of this in any genetic study is likely to result in erroneous conclusion (Allard and Bradshaw, 1964; Comstock and Moll, 1963). The estimate $\sigma^2\hat{gl}$ (GCA×location) were significant for days to 50% flowering, days to maturity, plant height, technical plant height, number of branches per plant, number of capsules per plant, harvest index and seed yield per plant in both the generations. The estimates of $\sigma^2\hat{sl}$ (SCA×location) indicated significant values for all the traits in both

the generations except number of seeds per capsule, harvest index in F_2 and oil content in F_1 reflecting the influence of external forces in case of these genetic parameters for yield and its contributing characters. The $\sigma^2\hat{gl}$ interaction were less in comparision to $\sigma^2\hat{sl}$ interaction for all the characters in both the generations except harvest index and number of capsules per plant (very narrow difference), exhibiting better stability in estimates of $\sigma^2\hat{g}$ which is fixable type of genetic variance. This type of genetic variance will considerably be smaller in early generation as compared to latter ones which reduced the efficiency of selection (Parlevliet and Comerin 1988).

It is quite clear from the study that both the additive and non-additive genetic components are responsible for controlling the most of these attributes. Good amount of additive as well as non-additive gene effects for seed yield and its components were reported by several workers for oil content (Singh and Singh, 1979; Bhatnagar and Mehrotra , 1980; Singh and Sindhu, 1986; Dang et al. 1987 and Patel et al. 1997); for seed yield and its components (Patil and Chopde, 1981; Doucet and Filipescu,1982; Kumar and Chauhan , 1982; Rao and Singh, 1984; Sharma, 1986; Rao and Singh, 1987; Tak and Gupta, 1989; Khorgade et al., 1992; Tak 1994; Mukul et al. 1994; Patel et al. 1997; Sukhovich 1999; and Yadav, 1999).

If the implication of information collected on nature and magnitude of gene action in the present study on breeding methodologies are considered, yield and its components traits (direct and indirect) had shown preponderance of non-additive genetic variance and also exhibited substantial amount of additive

genetic variance. Hence, improvement of such characters should be based on the simultaneous exploitation of both the additive and non- additive components of genetic variance. Therefore, progeny selection procedure in a large population might be adopted followed by modified pedigree method of selection as an alternative under such situation may be reasonable to resolve the difficulties. This method can be grouped into three categories (i) pedigree method (ii) bulk method (iii) back cross method.

Generally the objective of these methods is to develop pure line varieties and may be composited and used as a mixture of pure line. Modified pedigree method may also be used for selection from early segregating generations of crosses in self-pollinated crops. It is also useful in selection of new superior recombinants. It is hoped that some transgressive segregants would be recorded (transgressive breeding). Thus the method is suitable for improving specific characteristics, such as, disease resistance, plant height, days to maturity etc., as well as yield and quality characteristics. Even when the objective of a breeder is to correct specific weakness of a variety where he generally expects to improve the yield and quality as well.

Pedigree selection plan in self-pollinated crops have been reported by Rao and Das (1974) in flax, Rao and Singh (1984,1987) and Pillai et al. (1995) in linseed. Though the major constraints of using population improvement in self pollinated crops like linseed has been the difficulty in effecting massive gene flow during the recombination phase and limitation of seeds for testing in several environments.

The presence of predominantly large amount of non-additive gene action for seed yield and its several components are necessary for maintenance of heterozygosity in the population. Such type of genetic variability is non-fixable in nature and therefore, breeding methods such as biparental mating, followed by recurrent selection may result in faster rate of genetic improvement in characters to be improved up on.

Recurrent selection scheme in self fertilized species have been reported by Jensen (1970); Redden and Jensen (1974) in small grain of self pollinated species. They further outlined various ways for increasing recombinations in population which normally reproduce by self fertilization because of the mating flexibility of the crop floral and biological consideration.

COMBINING ABILITY FOR YIELD, ITS COMPONENTS AND QUALITY CHARACTERS

Selection of suitable strains/varieties and their crosses for effective hybridization is a prerequisite in order to chalkout a systematic and effective breeding programme which leads rapid and substantial improvement. The combining ability analysis provides such information for considerable improvement.

There are several criteria for selection of parents and their hybrid combinations namely, per se performance, GCA effects and involvement of desirable specific combinations which gives the idea about the potentiality of the parents/ progenies for mobilising them in a systematic breeding programme. The various methods (Griffing, 1956b; Kempthorne, 1957; Kempthorne and Curnow, 1961; Gardner and Eberhart, 1966) may or may not be comparable

with one another with equal weightage and result in placing parents with different combining ability effects in the same order of ranking. Even though a breeder is primarily interested in the relative and significant combining abilities rather than absolute combining abilities.

The per se performance of the parents was compared to their GCA effects in both the generations for all the 13 characters (Table 16). It was found that the per se performance in 12 out of 13 characters showed good general combiner in both the generations. In no case, the poor per se performance was the good general combiner. Therefore, under the present situation when the character is unidirectionally controlled by a set of alleles and additive effects are important, the choice of parents on the basis of per se performance may be quite useful. However, in certain cases, where non-allelic interactions are playing role, the choice of the parents should be based on their combining ability estimates.

The best common parents on the basis of per se performance and significant GCA effects in both the generations and pooled over locations were LMH-62, Sweta and Garima for days to 50% flowering; LMH-62 and RLC-6 for days to maturity; LMH-62, RLC-6, Garima and Shubhra for plant height; DPL-21, LCK – 88062 and KL-43 for technical plant height and for number of tillers per plant; LMH-62, Sweta and Shubhra for number of branches per plant; LMH-62 for number of capsules per plant; Neelam and LCK-88062 for number of seeds per capsule; Neelam and J-23 for 1000 seed weight; LMH-62, Garima, Shubhra and Neelam for harvest index; DPL-21, LCK-88062, KL-43 and Neelam for fibre yield per plant; LMH-62, RLC-6, Sweta, Shubhra and KL-

43 for oil content and LMH-62, Garima and LCK-88062 for seed yield per plant.

In case of GCA effects of the parents, it was observed that none of the parents was identified as good general combiner for all the 13 attributes. However, parent LMH-62 was good general combiner for days to 50% flowering, days to maturity plant height, number of branches per plant, number of capsules per plant, harvest index, oil content and seed yield per plant; Sweta, for days to 50 percent flowering, number of branches per plant and oil content; Garima, for days to 50 percent flowering, plant height, harvest index, and seed yield per plant; RLC-6 for days to maturity, plant height and oil content; Shubhra for plant height number of branches per plant, harvest index and oil content; DPL-21 for technical plant height, number of tillers per plant and fibre yield per plant; LCK-88062, for technical plant height, number of tillers per plant, number of seeds per capsule, fibre yield per plant and seed yield per plant; KL-43, for technical plant height, number of tillers per plant, fibre yield per plant and oil content; Neelam, for number of seeds per capsule, 1000 seed weight, harvest index and fibre yield per plant and J-23 for 1000 seed weight were found to be the best general combiner (Table 16).

Among the parents, LMH-62, Garima and LCK-88062 proved to be good general combiner for seed yield per plant in pooled estimates in both the generations. It is quite significant to note that LMH-62 was not only the good general combiner for seed yield per plant, but it was also a good general combiner for seven other characters namely days to 50% flowering, days to maturity, plant height, number of branches per plant, number of capsules

per plant, harvest index and oil content. Similarly, Garima was good general combiner for days to 50 percent flowering, plant height and harvest index and LCK-88062 for technical plant height, number of tillers per plant, number of seeds per capsule and fibre yield per plant.

Almost the equal magnitude of estimates of GCA effects in F_1 and F_2 generation revealed that the best general combiners were also stable in their performance over generations. It might be due to diversity of parents, diverse eco-geographical origin and variability in other agronomic attributes. The performance of poor general combiners were not consistent over the locations and over the generations. Stability for important agronomic traits has always been of the important parameters in breeding objective (Allard and Bradshaw, 1964).

GCA effects consist of both additive and additive×additive components of gene action (Griffing, 1956a, b; Sprague, 1966 and Gilbert, 1967) which was fixable. The additive effects of parents due to GCA are of practical use, whereas non-allelic interactions are not predictable and would not be easily manipulated .An examination of the best combiners has revealed that majority of them are derivatives of Indian origin. Hence, the derivatives present in linseed varieties/ strains did not lower down the yield and its contributing traits. The parents namely, LMH-62, Sweta, Garima, Shubhra, RLC-6, DPL-21, LCK-88062, KL-43 and Neelam were observed good general combiners for three to eight characters associated with seed yield per plant and quality attributes. Therefore, through the use of these strains/ varieties in further hybridization programme, the improvement will not be made only

for seed yield but also for fibre yield and oil content in this oil producing crop.

The good general combiners may be utilized in developing populations involving all possible crosses among themselves and may be subjected to biparental mating in early generations which helps in releasing latest genetic variability due to faster rate of recombinations. Singh et al. (1983) advocated this idea in other oil producing crop on the basis of GCA effects. Jensen (1970) suggested the idea of using developing population. There is provision in the method to make all possible ~~biparental~~ combination among selected parents and depending upon the number of F_1s in a diallel or partial diallel set or crosses among F_1s would be the material for initiating the breeding population. Such scheme was suggested by Frey (1975) in self pollinated crops.

Having considered all the attributes at the same time non of the hybrid combinations was found to be superior so far as SCA effects were concerned. Desirable and high significant SCA effects each in F_1 and F_2 progenies for seed yield per plant involving three combinations which revealed significant and desirable SCA effects. Normally a good cross combination is always lies between high ×high or high×low combinations.

Three hybrid combinations namely LMH-62/ DPL-21, LMH-62/ RLC-6 and LMH-62/J-23 showed significant and desirable SCA effects for seed yield per plant. These crosses also showed per se performance of ~~as~~ 8.91g, 8.86g and 8.56 g for seed yield per plant, respectively (Table 17a). Similarly in case of fibre yield per plant, desirable and high significant SCA effects were found in 5 crosses of each ~~the~~ generation. The hybrid combinations

were LMH-62/DPL-21, Neelam / LCK-88062, DPL-21/Garima, Neelam / KL-43 and Shubhra / LCK–88062 with per se performance of 4.09g 3.97g, 3.74g and 3.74 g, respectively. The most desirable combination, LMH-62/DPL-21 is found to be suitable for the development of double purpose strain.

The desirable SCA estimates were for involvement of diverse parents. Similar finding was reported by (Mishra 1990) in linseed involving diverse parents of different eco-geographical origin. It Clearly indicated the involvement of additive and/or additive×additive type of interaction.

Crosses, Neelam/LMH-62, LMH-62/DPL-21, LMH-62/ RLC-6, Sweta/LMH-62,Shubhra/LMH-62, LMH-62/J-23, RLC-6/ Garima and Sweta/LCK-88062 in F_1 generation while LMH-62/ RLC-6, Garima /KL-43, LMH-62/DPL-21, Neelam/LCK-88062 and Neelam/Garima in F_2 generation exhibited significant and desirable SCA effect involving one parent with desirable GCA effects and other parent with undesirable GCA effects (high×low) for seed yield per plant. Cross combination J-23/ Garima and LMH-62 /J-23 exhibited significant and desirable SCA effects for seed yield per plant in which both the parents were having desirable and significant GCA effects (h×h).

Similarly, crosses Shubhra/DPL-21, DPL-21/J-23, LMH-62/ DPL-21, Sweta/ DPL-21, DPL-21 /Garima and Subhra/LCK-88062 in F_1 generation; DPL-21/Garima, LMH-62/ DPL-21, and Shubhra/LCK-88062 in F_2 generation exhibited significant and desirable SCA effects involving one parent with desirable GCA effect for fibre yield per plant (high × low). Crosses, Neelam/LCK-88062, Neelam/KL-43 in F_1 generation and DPL-21/

LCK-88062, DPL-21/KL-43, KL-43/LCK-88062 and Neelam /KL-43 exhibited significant and desirable SCA effects in which both the parents were having significant and desirable GCA effects for fibre yield per plant (h×h).

The combinations which possessed high SCA effects with one good and one with poor combiner are the indicative of the presence of dominance and epistatic nature of the gene effects. Such specific combiners could produce desirable transgressive segregants, as reported by Jensen (1970)., Redden and Jensen (1974) in linseed.

HETEROSIS AND INBREEDING DEPRESSSION:

The heterotic parameters have been found to be most important genetic tool in accelerating the yielding ability of self, often cross and cross-pollinated plants of economic value. Self pollinated crops propagated by seeds do not have heterozygosity and are considered to produce homozygous segregants in advance generations. However, in case of linseed utilization of heterosis in the form of hybrid varieties does not seem to be economical and practically feasible for want of stable male sterility system.

Mather (1949), Mather and Jinks (1971) pointed out that maximum heterosis can be had either from the following causes or both (a) h>d at some or all loci, i.e., over dominance or superior dominance at some or all the loci where, h is the value of heterozygote and d is the value of homozygote, (b) r d= 0 i.e. genes dispersed among parental lines, rd is the distribution of genes among the parental lines. They further advocated that the greater extent of heterosis is obtained with accumulation of more

favourable and dominant genes which contribute more and more in the progeny.

Heterotic response has been worked out as a deviation of F_1 either from the mid parent value or superior parent of the crops or economic parent (well adopted cultivar of the area). In the present investigation heterosis was measured as deviation of the performance of hybrids from the superior parent of the crops and mid parental value. Because these two heterosis are of genetical importance and useful for genetic manipulation of hybrids more precisely.

Bailey et al. (1980) pointed out that the F_2 performance was a good indication of predicting F_1 performance in self pollinated crops. The use of parents, F_2 and three way crosses would give the performance of F_1 hybrids with increased accuracy and without field testing of F_1 progenies. Considering this inbreeding depression in F_2 generation was worked out.

Analysis of variance (Table 2a) revealed highly significant differences among the parents for all the 13 characters (except number of seeds per capsule and 1000 seed weight at Kanpur) which indicated the prevalence of large genetic diversity among the parents. Moll et al. (1962) reported that large magnitude of heterosis was linked with genetic diversity of the parents. Thus, the magnitude of heterosis calculated in this study for all the characters is not uncommon. Significant mean squares of parents vs F_1 s for most of the direct and indirect characters related to seed yield were also seem to be present.

Heterosis over superior parent for seed yield per plant was found to be highly significant and desirable in 23 crosses at all

the locations and pooled over locations. Majority of the hybrids also exhibited significant and desirable SCA effects. Out of 45 cases cross combination Sweta/ DPL-21 exhibited maximum 68.75 percent heterosis over superior parent on pooled basis. Other 5 best heterotic crosses over superior parent were Shubhra/Sweta(65.41%), Sweta/KL-43(51.23%), Shubhra/RLC-6 (45.49%), DPL-21 /KL-43 (41.65%) and DPL-21/ RLC-6 (38.65%) for seed yield per plant (table 18 a) which revealed high SCA effects for other attributes contributing for seed yield . Similarly 33 crosses revealed significant and desirable heterosis over mid parent at all the locations and pooled over locations. In order of merit five top ranking combinations for average heterosis were Shubhra / Sweta(100.75%), Sweta/KL-43(77.33%), Sweta/ LCK-88062(65.17), Shubhra/RLC-6(61.87%) and DPL-21/KL-43 (56.92%) (table 18-b). These crosses also revealed high SCA effects for other attributes related to economic yield.

Several workers had reported heterotic response in respect of seed yield per plant like Dubey (1967); Murty et al. (1967); Sehta and Comstock (1971); Anand et al. (1972); Chaudhary et al. (1972); Galkin (1973); Bhatnagar and Mehrotra (1979); Patil and Chopade (1983); Dakhore et al. (1987); Rao et al. (1987); Mishra (1987,1990,1993); Saraswat and Kumar (1993), Wang et al. (1996), and Singh (2002).

The hybrids giving significant and desirable heterosis for seed yield and its related characters were found to be advantageous for adequate exploitation of heterosis. Henceforth, major yield components may attribute significantly towards increased heterosis for seed yield or they have been found to

influence yield directly or indirectly in a positive direction. Many workers observed similar findings in case of GCA,SCA and component characters. Similar findings in case of GCA SCA and componental traits were observed by Joshi et al. (1961); Anand et al. (1972); Doucet (1978); Patil and Chopade (1981) ; Rao and Singh (1984); Thakur et al. (1988); Singh et al. (1990) , Khorgade et al.(1993); Yadav (1997) and Singh (2002). Not cited in Bibliography

In relay cropping system (present cropping scenario), there is an urgent need to take up linseed breeding programme to develop early maturing varieties. In this regard 8 hybrids at Rath, 5 at Jabalpur, 2 at Kanpur and 4 on pooled basis revealed significant and desirable heterosis over superior parent and 15 hybrids at Rath,13 at Jabalpur, 4 at Kanpur and 14 on pooled basis revealed desirable and significant heterosis over mid parent were found for days to 50% flowering. In case of days to maturity only 3 hybrids at Rath showed desirable and significant heterosis over superior parent whereas, eight hybrids at Rath and one hybrid revealed desirable negative significant heterosis over mid parent. The hybrids which did not show significant inbreeding depression indicating better selection response for selection of short duration genotypes in segregating generations. Such observations were reported by Pederson (1968); Singhania and Rao (1976); Patil and Chopade (1983) and Yadav (1997).

Three hybrids were found to be dwarf at Rath when heterosis over superior parent was determined. Five hybrids at Rath and 4 at Jabalpur revealed significant desirable heterosis over mid parent with regard to character plant height. Those hybrids

showed non-significant inbreeding depression in F_2 generation would be exploited in segregating populations.

Fibre yield is an important economic character mainly associated with the technical plant height. In this reference, 30 significant hybrids for technical plant height and 34 significant and desirable hybrids for fibre yield per plant in pooled analysis were found to be desirable over superior parent. Out of 30 hybrids, 5 hybrids Sweta/RLC-6, LMH-62/RLC-6,Sweta/Garima, LMH-62/ Garima and LMH-62/J-23 exhibited more than 35.25% heterosis over superior parent for technical plant height whereas crosses LMH-62 / RLC-6, Sweta /RLC-6, Sweta/Garima, LMH-62/Garima and LMH-62/ J-23 exhibited more than 63.98 percent heterosis over superior parent for fibre yield per plant. Similarly 41 F_1's for technical plant height and 42 F_2 s for fibre yield per plant exhibited significant and desirable heterosis over mid parent. Five crosses were common for both the heterosis namely; Sweta/ RLC-6; Sweta/Garima; LMH-62/J-23, LMH-62 /Garima and LMH-62/RLC-6 for technical plant height and Shubhra/LMH-62, Shubhra/KL-43, Sweta/RLC-6, Sweta /Garima, LMH-62/J-23, LMH-62 /RLC-6,LMH-62/Garima, LMH-62/ KL-43 ,J-23/KL-43 and RLC-6/KL-43 were for fibre yield per plant.

Being an oil seeds crop, oil content is an important character and the basic aim of linseed breeding is to increase oil production either by increasing oil content or seed yield or both. Out of 45 hybrids, 23 hybrids exhibited significant heterosis over superior parent and 39 over mid parent. The maximum heterosis was recorded for hybrid combination DPL-21/J-23 (3.07%) over superior parent and in Shubra/J-23 (4.9%) over mid parent. The

desirable and significant common combination for both the heterosis were, Sweta/LCK –88062, DPL-21/J-23 and DPL-21/ LCK-88062.

It was evident that there was reasonable amount of genetic diversity for this character in present set of parental lines. Hence, there is a need to screen out desirable segregants possessing high oil content in this crop for further exploitation of hybrid vigour. Heterotic response for oil content had been reported by Rao et al. (1987), Mishra (1993), Yadav (1997) and Singh (2002).

Inbreeding depression for seed yield per plant varied from -35.92 to 37.84 percent on pooled basis. In most of the hybrid which exhibited significant and high magnitude of heterosis also reflected significant inbreeding depression. Out of 45 hybrids, 29 crosses reflected significant inbreeding depression for seed yield per plant. Among eleven crosses Sweta/DPL-21 manifested high amount of heterosis over superior parent followed by Shubhra/ Sweta, Sweta /KL -43,Shubhra/RLC-6, and DPL-21/KL-43 for seed yield per plant but showed comparatively low inbreeding depression, such inconsistency between percent homozygosity and performance indicated that the increase of seed yield in these crosses might be due to gene interaction in which substantial part could be due to fixable gene effects.

An examination of GCA effects of the parents involved in the combination Sweta/LCK-88062, and DPL-21/RLC-6 revealed highly significant and desirable GCA effect in one parent correlated with high and significant SCA effect indicating the significant role of additive genetic effects. These crosses were likely to result some good transgressive in subsequent generation. Cross combination

DPL-21/ J-23 revealed high significant heterotic response (25.68%) over superior parent and high inbreeding depression (30.35%) in F_2 for seed yield. In this combination parent J-23 was good general combiner and DPL-21 was poor combiner. Higher inbreeding depression, desirable GCA effect in one of the parents and high SCA effect for seeds yield and some other direct and indirect component of it revealed the role of both additive and non-additive effects responsible for increasing the seed yield. Similar observation were recorded in case of heterosis over mid parent also.

Twenty four crosses revealed significant heterosis over mid parent out of which Shubhra/Sweta exhibited highest heterosis (100.75%) followed by Sweta/KL-43, Sweta/LCK-88062, Shubhra /RLC-6,DPL-21/Garima,Sweta/RLC-6andDPL-21/RLC-6. Combination Neelam/ LMH-62 revealed high significant heterosis over mid parent and higher inbreeding depression in F_2 for seed yield. In this combination one parent showed good general combiner and significant SCA effect in F_2 revealed the role of both additive and non-additive interaction for seed yield per plant. Out of 24 crosses, 4 crosses namely, Sweta/LCK-88062, Shubhra/ LCK-88062, LMH-62 / DPL-21 and DPL-21/LCK -88062 had high average heterosis ~~respectively~~, comparatively low inbreeding depression, significant SCA effect ~~and~~ involving one general good combiner, ~~parent~~ indicating the significant role of additive genetic effects for yield and most of its attributes. Most of the combinations revealed comparatively low inbreeding depression, significant SCA effect and non of the parent exhibited desirable GCA effects indicating the presence of non-additive genetic effects. Increase in seed yield in these crosses might be due to fixable gene effects.

On the other hand crosses showed significant and high heterosis with significant positive inbreeding depression which might be due to non-allelic gene interaction. Jatasara et al. (1980) observed that the combinations showed pronounced heterosis in F_1 and high inbreeding depression in F_2 indicating non-allelic gene interaction in self pollinated crops.

Brim and Cockerham (1961) pointed out that when additive gene effects were large, the depression in F_2 would be low and vice-vera. The componental traits under study were indicating high degree of heterosis (more than 25%) and also exhibiting high degree of inbreeding depression (more than 12%). On the other hand, developmental trait like days to 50% flowering days to maturity and plant height, indicated low amount of inbreeding depression reflecting that more reliance could be planed on these attributes in case of selection. Mishra (1987), Saraswat and Kumar (1993) and Yadav (1997) observed high amount of heterosis followed by high degree of inbreeding depression for various attributes in linseed.

Considering simultaneously the behaviour as well as extent of heterosis and inbreeding depression for seed yield and its related components and growth attributes in the present material, it ~~would be~~ is emphasized that ideal combinations for exploiting heterosis in linseed would be one which has significant estimates of SCA effects and atleast one of the parent involved must be a good general combiner. Thus, the application of these parameters could certainly be helpful to minimize the problem of handling ~~of~~ large number of crosses in segregating generations.

ADAPTABILITY STUDIES IN LINSEED:

A specific genotype may not produce the same phenotypic expression in all the environments and due to the fact different genotypes interact differently in different environments. It is the reason that the programme of plant breeding aims at developing stable cultivars which yield could not be reduced due to environmental factors.

Genotype × Environment interaction is differential genotypic expression across the environments. It reduces the relationship between phenotypic and genotypic value and may effect selection from one environment to another. Measurement of genotype × environment interaction is also important to formulate an optimum breeding strategy. Some prefers the term adaptation in the context of spatial variation and use the term stability for performance at a given location.

Allard (1960) described the biological complexity underlying genotype × environment interaction; virtually all phenotypic effects are not related to gene in any simple way. Rather, they result from a chain of physicochemical reactions and interactions initiated or modified by other genes and the external environment, to the final phenotype.

There are two different approaches for studying G×E interaction and adaptation. The more common is empirical and statistical and involves observed genotypic responses, usually in terms of yield to a sample of environment and phenotypes in terms of biotic and abiotic factors. In practice, most of the breeding programmes include element of both the approaches.

Two types of genotypic stability were distinguidshed by Backer (1981). He applied the word 'biological' to stability in homeostatic sense in which a genotype maintains a constant yield across the environments. Statistically, this concept of stability is assessed by genotypic variance across the environments. However, homeostatic stability trends to be undesirable in modern agriculture, genotypes responds to improved conditions. The need for genotypic responsiveness to favourable environments lead to the concept of 'agronomic' stability, by which a genotype is considered to be stable in case relates to the productive potential of test environments. If agronomic stability is worked out in a wide range of environments, genotype is defined as having general or wide adaptation.

With the development of high yielding varieties in linseed many varieties of high oil content and fibre yield possessing desirable agronomic attributes are getting popularity in adaptation. The nature of their adaptation, as the major component of productivity was analysed. Such analysis is of major significance in oil content not only for the genetical or evolutionary stand point, but also provides basis for better understanding of the problems of production in general and of plant breeding in particular.

The stability analysis provides information regarding adaptabity of genotypes for their suitability over wide array of agro-climatic conditions. If adaptability in real sense is genetic characteristics preliminary evaluation can be made to identify the stable genotypes in early generations. The more stable genotypes and their combinations developed for final stages of testing will provide better opportunity for the breeder to take up intensive

selection programme. However, selection for stability is not possible unless a model with suitable parameters is applied to have the criteria essential to rank the genotypes for their stability.

Plant breeders are interested in releasing the variety with an above average performance in all the environments. Thus the variety with high per se performance higher than population mean $(\overline{X})$, unit regression coefficient (bi), and smallest deviation from regression (s^2_{di}) will be the automatic choice for selection. According to Langer et al. (1979), the regression coefficient is a measure of response to varying environments. The mean squares for deviation from linear regression is a true measure of production stability.

In the present study, 10 parents and 45 F_2,s were involved as the material for determination of stability parameters based on Eberhart and Russell (1966) model of three different locations namely, Rath (Hamirpur), Jabalpur and Kanpur. The experimental finding revealed that the pattern of genotype×environment interaction among the genotypes was not the same, but it varied from character to character.

The stability analysis (Table11) revealed highly significant differences among the genotypes for all the 13 characters and genotype × environment interactions component also indicated highly significant differences for all the characters. It is obvious to say that the average performance of genotypes (parents and F_2) for seed yield and other contributing characters differed significantly. Similar results has been reported by Khatyaleva (1987),Rai et al.(1989), Popescu (1991) and Mishra et al. (1992).

The environment (linear) component was highly significant for all the characters. The variance due to pooled deviation (non-linear) was highly significant for all the characters indicating substantial amount of genetic diversity in the material, such observations were advocated by Perkins and Jinks (1968a,b). The non-linear deviation may be of practical use of that the utility of multiple regression model to know the more critically the complex mechanism of adaptation.

The attributes represented more number of loci were reported to be less stable and much reflected considerable interaction (Robinson et al. 1965; Gamble1962). In the pooled combining ability analysis (Table 7) interaction component (σ^2gl + σ^2sl) as compared to genetic component (σ^2g+σ^2s) indicated poor stability for most of the attributes under the study. Vanderveen (1959) pointed out that the presence of linkage and epistatic effects might be caused some favour in the estimation of stability parameters.

The population can achieve stability by two ways, (i) individual buffering, belonging to homogeneous population such as inbred lines, pure line or single cross and (ii) population buffering, referring to the buffering which comes out from the interaction of different coexisting genotypes (heteorogeneous population).The relationship has been reported in both the plants and animals between stability and degree of heterozygosity. However, there is an equal amount of evidence that stability can formulate gene system unrelated to heterozygosity. Some workers had reported that F_2s were more stable than their homozygous parents, while other observed that the parents were found to be more stable than single

crosses, double crosses as compared to single crosses (Jones, 1958), mixture as compared to pure lines and F_2 s as compared to F_3 s were more stable (Gautam and Jain, 1978).

A good amount of genotype × environment (linear) component indicated that genotypes deviating from the regression line of unit slope could be identified. Accordingly, three kinds of linear responses namely, b=1,b>1and b<1/b<0 have normally been observed in respect of all the characters (table12). However, negative values were observed for plant height, technical plant height, harvest index, fibre yield per plant and oil content in both the population (parents and F_2s) this type of linear response could be due to sampling error or different scales used in taking observations.

The large variation in regression coefficient revealed that the genotypes (Parents and F_2s) had shown different environmental responses. Pfahler and Linkson (1979) pointed out that to some extent, variability observed among the environments could be determined to see the usefulness of regression response parameter. In the present set of material, none of the parents and F_2s showed average stability when all the three parameters were considered together for all the characters at a time. However, parents LMH-62, KL-43 and RLC-6 for seed yield; LCK-88062 and Neelam for fibre yield and Sweta and RLC-6 for oil content were more adaptable on the basis of their performance under wide range of environmental fluctuations and had exhibited non-significant deviation from regression and regression coefficient was less than unity. Among these, RLC-6 and KL-43 seems to be common with high yield and

oil content hence the use of these parents may be more useful in our breeding programme.

Six cross combinations namely, LMH-62/Garima; RLC-6/Garima; Sweta/ Garima; RLC-6/LCK-88062; Garima/ LCK-88062 and DPL-21/LCK-88062 were found to be stable for seed yield per plant. Cross LMH-62/Garima was found to be stable for other three characters namely plant height, number of capsules per plant and harvest index, RLC-6/Garima for plant height, Sweta/Garima for number of seeds per capsule and harvest index and Grima/LCK-88062 for technical plant height, 1000 seed weight and harvest index. Similarly cross combinations, LMH-62/DPL-21; DPL-21/KL-43,LMH-62/LCK-88062 and Garima/KL-43 were found stable for fibre yield per plant. Out of which cross LMH-62 /DPL-21 was found to be stable for technical plant height, number of branches per plant, DPL-21/KL-43 for number of tillers per plant, LMH-62/LCK-88062 for technical plant height, number of capsules per plant and oil content and Garima/KL-43 for oil content also.

It could be pointed out that in above genotypes, the component characters might shift in compensatory manner in the changing environment in order to give consistent performance for final character i.e. yield (seed yield, fibre yield or oil yield). If the component characters did not adjust themselves to a changed environment, then the population could be less buffered for the final character. This sort of compensatory mechanism for component characters in imparting homeostasis has been emphasized by Grafius (1956) in oats. On the other hand developmental traits such as plant height, technical plant height

and days to maturity were also found to be stable in the material studied in the present investigation.

Stability parameters were studied by many workers in linseed with regard to seed yield and yield contributing characters. Mahto, (1995), Mahto et al. (1995); Mahto and Singh, (1996); Payasi and Bose (1999); Yadav and Ram Krishna (2000) and Yadav et al. (2000) studied the association of linear and non linear components for seed yield stability.

HERITABILITY AND GENETIC ADVANCE:

The systematic breeding programme depends upon three main important stages (i) creating genetic variability (ii) practicing selection and (iii) utilization of selected genotypes for developing promising hybrids/varieties in economic crop plants. In case of direct selection parameters, heritability and genetic grain are fundamentally important investigation. The two parameters were worked out in first and second filial generations in linseed involving 45 crosses in each.

Heritability gives a statistical concept and is used in estimating expected progress determining the degree to which the character is transmitted from parent to their offsprings. It provides the comparative value of heredity and environment on character variation. The effective improvement in a particular character/characters for which the selection is made will be based on the quantum of genetic advance. Robinson et al.(1955) reported that without genetic advance, the estimates of heritability could not be of practical utility for selection based on phenotypic appearance. According to Hensen (1963), heritability estimates

were influenced by methods of estimation generation to study, environmental samples employed and environments. According to Kung (1977), genetic gain would be over estimated in either of the following situation (i) low selection proportion with high heritability and (ii) high selection proportion with low heritability.

Selection for one or more characters results in correlated response for many other characters (Falconer, 1960 and Searle, 1965) and the pattern of variation will also be changed (Waddington and Robertson, 1966).Hence, the component of selection parameter from a selected group of population will probably be different from those involving diverse material. Such changes would be quite substantial with the useful genes and intense selection for an ideal plant type which included developmental, component and quality characters pertaining to productivity.

Heritability estimates in pooled analysis (Table13) were observed higher for days to 50% flowering, plant height, harvest index, fibre yield per plant, oil content and seed yield per plant in both the generations which might be due to contribution of more additive genetic component in the inheritance of these traits. It obviously indicates that if these characters are subjected to mass selection and /or any other selection scheme aimed at exploiting fixable (additive) genetic variance, a widely adapted genotypes/strains could be developed which may possess good quality and productivity. High heritability estimates were reported earlier by Rosbac, (1966). Rai (1967); Chaudhary et al. (1972); Dayal et al. (1975) ;Rai and Das (1975);Rai (1976); Srivas and Singh (1984);Rao and Singh (1985);Galkin and Sorochinskaya

(1986); Singh and Dixit (1988); Rai et al. (1989). Jagdev (1990); Nie et al. (1991); Mahto and Mahto (1998); Yadav and Gupta (1999) and Rai et al. (2000) for different yield contributing traits.

Most of the characters in F_2 at different locations (Rath, Jabalpur and Kanpur) had given higher heritability values than F_1 progenies. These higher estimates could be due to presence of additive×additive gene interaction in segregating generation. Under such situation. Intensive selection pressure during selection breeding programme could be given in early segregating generations and may be carried out in the advancement of generation.

Genetic gain in percent of mean (Table 14) was observed to be high for days to 50% flowering, plant height, fibre yield per plant and seed yield per plant coupled with high heritability estimates in both the generations and number of tillers per plant in F_1 coupled with moderate to high estimates of heritability. It clearly indicated the greater role of additive genes than non-additive genetic components. These finding were in agreement with those of Singh (1984); Ingale (1985);Rao and Singh (1985); Satpathi et al. (1987); Jagdev (1990): Kalpna Mishra (1992); Pillai (1994), Jagdev (1995); Mirza et al. (1996); Yadav and Gupta (1999) and Rai et al.(2000).

BREEDING METHODS:

It is significant to point out the relevant breeding methods should be taken into account considering the gene action for characters like seed yield per plant, fibre yield per plant, number of tillers per plant, technical plant height, number of

capsules per plant, oil content and 1000 seed weight in the investigation, clear cut role of additive and non additive gene effect have been witnessed for these characters. However, the prepoderance of non-additive gene effects have been noticed for yield components namely, technical plant height, number of tillers per plant number of branches per plant number of capsule per plant and so on. Consequently, the improvement related to such characters should be dependent on simultaneous exploitation of both types of component of genetic variance. No dout, the traditional breeding methods are normally characterized to see that portion of genetic variability which is because of additive and additive ×additive kind of gene action. If there is influence of non-additive genes action for yield and its components naturally it gives the idea about heterozygosity in the population and this type of gene action is considered to be non-fixable in nature. In order to increase the rate of genetic improvement with regard to these characters the application of biparental mating and reciprocal recurrent selection is effective.

No doubt these approaches are practically difficult to be applied in self-pollinated crops. The basic difficulty in application of recurrent selection in self pollinated species is to initiate the recombination portion of each selection cycle. Miller and Rawlings (1967) had given the idea about use of recurrent selection method as the substitute of conventional breeding approaches in self pollinated species. This method has been suggested for improvement of tobacco and field pea.

Genetic approaches through adoption of diallel mating system by mass selection and thereafter co~~n~~ncurrent random

mating as advocated by Jensen (1970) and used by Redden and Jenes (1974) for improvement of small grain crops may also be helpful for further improvement of linseed. But on the basis of present findings, breeding procedures such as pedigree method ~~for~~ modified pedigree method suggested by Brim (1966) can be employed for the improvement of such character which are predominated by additive type of genetic components as suggested by Brim (1966) whereas the characters which are predominantly controlled by non-additive, as in case of our study dominance types of genetic components may be improved though recurrent selection methods as suggested in self pollinated crops by Frey (1975) and Richie and Gardner (1975).

Combinations namely, Sweta/DPL-21; Shubhra/Sweta; Sweta/ KL-43; Shubhra/RLC–6;DPL-21/KL-43, DPL-21/RLC-6, Sweta /LCK-88062, Shubhra/J-23, Neelam/RLC-6, Sweta/RLC-6 and DPL-21 / RLC-6 were found promising in yield and other yield contributing components based on superior parent heterosis. Based on average heterosis combinations, Shubhra/Sweta, Sweta/KL-43, Sweta/LCK-88062, Shubhra/RLC-6 and DPL-21/ KL-43 were found to be promising in yield and yield contributing components. These hybrids may be handled further with the help of pedigree, back cross techniques to sort out the favourable segregants. Finally it is suggested that breeding approaches like population improvement concept in the form of biparental mating followed by reciprocal recurrent selection might be more meaningful to evolve high yield potential with high oil content and other desirable characters in this crop.

Chapter-VI

SUMMARY AND CONCLUSSION

SUMMARY AND CONCLUSION

"Studies on the stability parameters and biometrical traits of yield and yield contributing characters in linseed (<u>Linum</u> <u>usitatissimum</u> L.)" was carried out to gather the information on yield, quality and developmental traits pertaining to productivity involving 10 parents of wider genetic base and their all possible crosses under diallel mating design in linseed. The final experiment was conducted in Randomized Complete Block design with three replications at three diverse locations namely, Rath (Hamirpur), Jabalpur and Kanpur in the Rabi season of 1998-99. The experiment consisted of 10 parents and their 45 F_1s and F_2s of straight single crosses with no reciprocals at each location.

The observations on 13 characters at all the three locations in parents, F_1s and F_2s were recorded with regard to days to 50% flowering, days to maturity, plant height, technical plant height, number of tillers per plant, number of capsules per plant, number of seeds per capsule, 1000 seed weight, harvest index, fibre yield per plant, oil content in percent and seed yield per plant. Data were put to different statistical analyses viz; component analysis for gene action, combining ability, heterosis, inbreeding depression, stability parameters, heritability and genetic advance. The results of the study have been attributed to succeeding paragraphs.

Analysis of variance revealed significant differences among the treatments for all the characters at all the locations and in both the generations. The orthogonal break up of treatment

mean sum of squares like parents vs F_1s and parents vs F_2s were also significant for all the traits in both the generations at all the locations and pooled over locations.

High degree of variability was observed in all the traits for all the locations and pooled over locations. However, its magnitude varied from character to character and generation to generation.

The variance component analysis showed highly significant differences for additive component at all the locations in both the generations for days to 50% flowering, plant height, number of capsules per plant, fibre yield per plant, oil content and seed yield per plant whereas, it also indicated significant differences in number of seeds per plant, technical plant height and 1000 seed weight at all the locations and in days to maturity at Rath and Kanpur in F_2 generation.

Dominance components ($\hat{H}_1$ and $\hat{H}_2$) showed highly significant values for all the characters in both the generations except technical plant height for $\hat{H}_1$ in F_2 at Kanpur; number of tillers per plant for both $\hat{H}_1$ and $\hat{H}_2$ at Jabalpur and in F_2 at Kanpur; days to maturity, number of branches per plant and harvest index for both $\hat{H}_1$ and $\hat{H}_2$ in F_2 at Kanpur.

Combining ability variance analysis was conducted for 13 characters in F_1 and F_2 generations separately for all the locations. In F_1 s, the mean sum of squares due to GCA and SCA was recorded highly significant for all the characters at each location.

In F_1, the values of GCA variance were less than those of SCA variance for all the characters at all the locations except for

days to maturity at all the locations, plant height at Jabalpur and Kanpur, days to 50% flowering and fibre yield per plant at Rath and Kanpur where GCA variance was higher. In F_2, mean sum of squares of GCA and SCA were significant for all the characters at all the locations. The estimates of GCA variance were less than SCA variance for most of the yield contributing characters at all the locations except plant height and oil content at all the three locations; days to 50% flowering and seed yield per plant at Rath and Jabalpur; technical plant height and fibre yield per plant at Rath and Kanpur.

The high estimates of $\sigma^2\hat{g}$ were present in comparision to $\sigma^2\hat{s}$ for the characters namely days to 50% flowering, plant height, number of tillers per plant, fibre yield per plant in both the generations and for days to maturity in F_1 while other characters showed high estimates of $\sigma^2\hat{s}$. The $\sigma^2\hat{sl}$ interaction was comparatively higher than $\sigma^2\hat{gl}$ interaction for all the characters except number of capsules per plant and harvest index in both the generations indicating better stability in all the traits except number of capsules per plant and harvest index.

The sum of interaction components ($\sigma^2\hat{gl}+\sigma^2\hat{sl}$) exceeded the sum of genetic variances ($\sigma^2\hat{g}+\sigma^2\hat{s}$) for days to 50% flowering, days to maturity, number of capsules per plant, number of seeds per capsule, 1000 seed weight in both the generations, while characters, plant height, number of tillers per plant, number of branches per plant, harvest index and oil content reflected higher values in F_2 generation.

The estimates of $\sigma^2\hat{gl}$ were significant for days to 50% flowering, days to maturity, plant height, technical plant height,

number of branches per plant, number of capsules per plant, harvest index and seed yield per plant in both the generations whereas, 1000 seed weight in F_2 generation and fibre yield per plant in F_1 generation showed same significant differences. The $\hat{\sigma^2 gl}$ interactions were less in comparision to $\hat{\sigma^2 sl}$ interaction for all the characters in both the generations except number of capsules per plant and harvest index in both the filial generations. The interaction of $\hat{\sigma^2 sl}$ revealed significant differences for all the characters in both the generations except number of seeds per capsule, harvest index in F_2 and oil content in F_1 generation.

The mean performance and significant GCA effects revealed that the parents LMH-62, Sweta and Garima were good general combiners in both the generations and in pooled analysis for days to 50% flowering; LMH-62 and RLC-6 for days to maturity; LMH-62, RLC-6, Garima and Shubhra for plant height; DPL-21, LCK-88062 and KL-43 for technical plant height and for number of tillers per plant; LMH-62, Sweta and Shubhra for number of branches per plant; LMH-62 for number of capsules per plant; Neelam and LCK-88062 for number of seeds per capsule; Neelam and J-23 for 1000 seed weight; LMH-62, Garima, Shubhra and Neelam for harvest index; DPL-21, LCK-88062, KL-43 and Neelam for fibre yield per plant; LMH-62, RLC-6, Sweta, Shubhra and KL-43 for oil content and LMH-62, Garima and LCK-88062 for seed yield per plant .It is significant to point out that the parent LMH-62 amongst all was found to be best general combiner for more than 55 percent of the characters while LCK-88062 for more than 35 percent and Garima, Shubhra, KL-43 and Neelam for more

than 30 percent and Sweta and RLC-6 for more than 20 percent were as best combiners.

The significant and desirable SCA effects for seed yield were found in eight combinations in F_1 and in five combinations in F_2 generation. These combinations involved all sorts of possible combinations between higher and lower order of GCA effects. Crosses Neelam/LMH-62,LMH-62/DPL-21,LMH-62/RLC-6, Sweta/LMH-62, Shubhra/LMH-62, LMH-62/J-23, RLC-6/Garima, Sweta/LCK-88062 in F_1 generation; LMH-62/RLC-6, Garima/KL-43, LMH-62/DPL-21, Neelam/LCK-88062 and Neelam /Garima in F_2 generation exhibited significant and desirable SCA effects involving one parent with desirable GCA effect and other parent with undesirable GCA effects for seed yield per plant. The cross combinations exhibiting significant and desirable SCA effects and in which both the parents were having desirable and significant GCA effects were J-23 /Garima and LMH-62/J-23. In case of fibre yield per plant cross combinations Shubhra/DPL-21, DPL-21/J-23, LMH-62/DPL-21, Sweta/DPL-21, DPL-21/Garima and Shubhra/LCK-88062 in F_1 generation; DPL-21/Garima, LMH-62/DPL-21 and Shubhra /LCK-88062 in F_2 generation exhibited significant and desirable SCA effects involving one parent with desirable GCA effects for fibre yield per plant. Crosses Neelam/LCK-88062 and Neelam/KL-43 in F_1 and crosses DPL-21/ LCK-88062, DPL-21/KL-43, KL-43, LCK-88062 and Neelam/KL-43 exhibited significant and desirable SCA effect with both the parents were having significant and desirable GCA effects for fibre yield per plant. Cross LMH-62/DPL-21 exhibited significant and desirable SCA effect involving one parent with desirable GCA effect was common for

both seed and fibre yield therefore, it is highly considerable for the development of double purpose variety.

Heterosis estimated in percent over the superior parent for seed yield was significant and positive in 23 crosses on pooled basis. Majority of the hybrids also exhibited desirable and significant SCA effects. Whereas 33 crosses revealed significant and desirable heterosis over mid parent on pooled basis. The maximum 68.75 percent heterosis over superior parent was observed in case of Sweta/DPL-21 followed by Shubhra/Sweta (65.41percent), Sweta/KL-43 (51.23 percent), Shubhra/RLC-6 (45.49 percent), DPL-21 /KL-43 (41.65 percent), DPL-21/RLC-6 (38.65 percent) Sweta/LCK-88062 (37.77 percent), Shubhra/J-23 (33.98 percent), Neelam /RLC-6 (30.98 percent) and Sweta/RLC-6 (27.95 percent) for seed yield per plant and other attributes. Five top ranking cross combinations exhibiting average heterosis were Shubhra /Sweta (100.75 percent), Sweta/KL-43 (77.33 percent), Sweta/LCK-88062 (65.17 percent), Shubhra/RLC-6 (61.87 percent) and DPL-21/ KL-43 (56.92 percent) for seed yield per plant and other related characters. Significant inbreeding depression for seed yield was noted in 29 crosses .The highest magnitude of inbreeding depression was noted for the cross Neelam /LMH-62 (37.84 percent) and minimum negative inbreeding depression (-35.92 percent) was expressed by the cross Shubhra/ DPL-21 for seed yield per plant. Increase in seed yield was due to non-additive genetic component as manifested by the preponderance of dominant genes for high yield in the present set of material.

The stability analysis revealed that genotype × environment interactions were highly significant for all the

characters. The non-linear components (pooled deviation) were also found to be highly significant for all the characters. The environment (linear) component was highly significant for all the characters. The large variation in regression coefficients revealed that the varieties/species and their F_2s had different degree of environmental response. Non of the parents and F_2s manifested average stability when all the three parameters were considered together for all the characters. However, parents LMH-62, KL-43 and RLC-6 for seed yield per plant; LCK-88062 and Neelam for fibre yield per plant and Sweta and RLC-6 for oil content were found to be stable on the basis of their performance under wide range of environmental fluctuation. Stability parameters for 45 F_2 s were worked out at all the locations for all the characters and out of these six combinations namely, LMH-62/Garima, RLC-6/Garima, Sweta/Garima, RLC-6/LCK-88062, Garima/LCK-88062 and DPL-21/LCK-88062 for seed yield per plant and cross combinationsLMH-62/DPL-21,DPL-21/KL-43, LMH-62/LCK-88062 and Garima/KL-43 were observed highly stable for fibre yield per plant.

High heritability estimates were observed for days to 50% flowering, plant height, harvest index, fibre yield per plant, oil content and seed yield per plant in both the generations, while it was moderate for technical plant height and number of capsules per plant in F_1 and for days to maturity, number of tillers per plant, number of branches per plant and number of capsules per plant in F_2 population on pooled basis. The low heritability estimates were noted for number of branches per plant and number of capsules per plant, 1000 seed weight in F_1 on pooled basis.

Expected genetic gain was high for days to 50% flowering, plant, height, fibre yield per plant and seed yield per plant coupled with high heritability estimates in both the generations and for number of tillers per plant in F_1 and for technical plant height in F_2. Medium genetic gain was worked out for harvest index in both the generations, for days to maturity and for technical plant height in F_1; for number of tillers per plant, number of branches per plant, number of capsules per plant, number of seeds per capsule and 1000 seed weight in F_2. Rest of the characters exhibited low estimates of genetic gain.

On the whole, it is suggested that population improvement concept ~~with the~~ like use of biparental mating, reciprocal recurrent selection followed by concurrent breeding approach would be more helpful for those characters which are governed by non-additive gene action. Pedigree method and back cross procedure are equally important for the improvement of yield characters governed by additive type of gene. After all possible combinations, the handling of material may be carried out with the help of pedigree and mass selection. No doubt this study will definitely help the plant breeders dealing with the crop to check out the sound breeding programme for enhancing yield with other characters in order to release varieties of high yield level with stable performance in all kinds of environments.

It is also suggested that the breeding strategy for such valuable crop like linseed should be initiated separately for the development of seed type, double purpose type (seed and fibre) and flax type to utilize each and every part of the crop.

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TABLES
1-18

Table-1: Description of parents/genotypes involved in the study.

S.No.	Strain/ Variety	Pedigree	Source of origin	Salient features
1-	Neelam	[T-1/NP(RR)9]	Kanpur, U.P.	Medium tall, erect and almost compact, blue flower, medium to late maturity, brown coloured, bold seeded, resistant to rust and tolerant to wilt, vigorous growth with high biomass, highly input responsive under irrigated condition.
2-	Shubhra	[Mukta/K-2]	Kanpur, U.P.	Medium erect, good primary branches, flower medium white, matures in 125-130 days, brown medium bold seeded, resistant to rust, moderately resistant to Alternaria blight and moderately resistant to Powdery mildew, oil contents45%
3-	Sweta	[Mukta/T-1206]	Kanpur, U.P.	Medium statured suitable for rainfed conditions, maturing in 130-135 days, uneven light brown medium seeded, resistant to blight, oil content 44%.
4-	LMH-62	[(EC41628/EC77959)// (DPL-20/Neelam]	Mauranipur, U.P.	Short statured height, blue medium size flower, brown colour seeded, maturing in 125-130 days, high input responsive, moderately resistant to rust, resistant to powdery mildew and tolerant to wilt, Alternaria blight and bud fly, oil content 42.6%.
5-	DPL-21	[Summit/LC-216]	H.P.	Double purpose variety, late in maturity, blue flower, brown medium seeded, resistant to rust, wilt, Powdery mildew, frost and lodging, oil content-45%.

Table Contd……

6-	J-23	[ES 9832/ Hira]	Jabalpur, M.P.	Medium height, white flowered, light yellow seeded, moderately resistant to Alternaria blight, good yielder recommended for rainfed condition for Bundelkhand region, oil content 44%, seed type.
7-	RLC-6	[(Afg-8/R-1)//Afg-8]	Raipur, M.P.	Medium dwarf height, medium capsule, light brown seeded, medium blue flower, resistant to rust, wilt and Powdery mildew, oil content 43%.
8-	Garima	[T-126/Neelum]	Kanpur, U.P.	Medium dwarf erect, medium in maturity, brown colour bold seeded 42% in oil content, resistant to rust and tolerant to Powdery mildew, Alternaria blight, input responsive, suitable for irrigated conditions.
9-	KL-43	[New River/LC-216]	H.P.	Erect, tall, violet flower, medium capsule, brown seeded long duration, resistant to rust, wilt and P.M.; oil content 42%.
10-	LCK-88062	[Mukta/Flax purple]	Kanpur, U.P.	Medium tall, dark brown seeded, medium in maturity duration , suitable for high fertility and assured moisture condition, oil content more than 40%, tolerant to Wilt and Alternaria blight and resistant to bud fly.

Table- 2 (a): ANOVA for 13 characters in 10 parents diallel - cross and their F_1 s in linseed: Mean squares.

Source of Variation	d.f.	Days to 50% flowering			Days to maturity			Plant height (cm.)			Tech. Plant height (cm.)\		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Replications	2	0.624	0.073	3.224	3.436	7.861**	14.255**	37.539	88.323	30.272	10.588	18.796**	20.711
Treatments	54	208.932**	53.840**	119.314**	50.462**	29.523**	84.636**	261.473**	201.765**	438.019**	498.225**	261.232**	684.157**
Parents	9	266.740**	70.498**	159.870**	87.613**	46.404**	92.492**	532.870**	537.116**	289.981**	468.374**	99.943**	375.022**
F_1 s	44	201.492**	50.176**	110.645**	42.333**	25.448**	83.718**	142.620**	121.560**	421.407**	402.629**	218.708**	700.422**
Parents vs F_1s	1	16.004**	61.100**	135.761**	73.578**	56.874**	50.414**	2915.845**	712.946**	2501.614**	4972.966**	3584.03**	2750.795**
Error	108	1.958	1.375	2.304	1.807	2.552	2.495	29.095	58.569	52.523	14.879	6.624	12.177

Source of Variation	d.f.	No. of tillers per plant			No. of Branches per plant			No. of Capsules per plant		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Replications	2	0.188	0.870**	0.051	10.479	1.086	42.525**	70.423	6.874	87.891**
Treatment	54	8.522**	3.380**	3.498**	212.702**	255.875**	67.000**	317.978**	568.356**	227.582**
Parents	9	6.210**	15.062**	1.912**	22.996**	39.016**	51.631**	279.042**	362.197**	82.733**
F_1 s	44	8.612**	3.005**	2.737**	139.052**	173.206**	50.852**	254.376**	400.946**	172.548**
Parents vs F_1 s	1	25.385**	4.733**	51.225**	5160.682**	5844.955**	915.773**	3467.594**	9789.412**	3952.749**
Error	108	0.138	0.315	0.113	6.411	12.238	19.862	47.862	20.072	21.050

Table Continue-

Source of Variation	d.f.	No. of seed per Capsules			1000 Seed weight (g.)			Harvest Index %		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Replications	2	0.043	0.021	0.184	0.071	0.065	28.812	1.480	10.256	14.270**
Treatment	54	1.719**	1.311**	2.017*	2.430**	1.031**	110.107**	40.075**	55.605**	41.838**
Parents	9	0.893**	1.084**	2.907*	3.296**	0.681**	1.593	48.193**	45.888**	41.370**
F_1 s	44	1.031**	1.164**	1.857**	1.418**	0.673**	132.507**	21.564**	37.219**	32.027**
Parents vs F_1 s	1	39.398**	9.805**	19.036**	39.176**	19.916**	101.153**	781.484**	952.042**	477.660**
Error	108	0.116	0.042	1.028	0.043	0.107	27.973	5.05	6.405	5.531

Source of Variation	d.f.	Fibre yield per plant (g.)			Oil Content (%)			Seed yield per plant (g.)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Replications	2	0.042*	0.124**	0.091**	0.026	0.026	0.027	0.325	0.015	0.044
Treatment	54	3.430**	2.427**	4.616**	2.858**	2.294**	3.119**	7.830**	4.845**	5.516**
Parents	9	3.430**	2.193**	3.573**	5.304**	2.851**	3.348**	10.767**	4.081**	4.182**
F_1 s	44	2.865**	2.135**	4.459**	1.543**	1.740**	2.101**	5.391**	3.812**	4.736**
Parents vs F_1 s	1	28.275**	17.403**	20.899**	39.038**	21.719**	45.905**	88.709**	57.144**	51.840**
Error	108	0.017**	0.042	0.031	0.213	0.166	0.139	0.198	0.154	0.063

* Significant at $p = 0.05$ L_1 = Rath (Hamirpur); L_2 = Jabalpur (M.P.);

** Significant at $p = 0.01$ L_3 = Kanpur

Table-2 (b): ANOVA for 13 characters in 10 parents diallel – cross and their F_2 s in linseed : Mean squares.

Source of Variation	d.f.	Days to 50% flowering			Days to maturity			Plant height (cm.)			Tech. Plant height (cm.)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Replications	2	2.297	1.642	16.006**	1.897	35.525**	4.806*	18.320	39.92	8.788	16.828	63.764**	23.972
Treatments	54	201.186**	36.355**	111.80**	145.072**	342.08**	125.875**	328.061**	159.543**	200.845**	216.645**	130.894**	225.881**
Parents	9	266.74**	70.50**	159.87**	87.613**	46.40**	92.49**	532.87**	537.116**	289.98**	468.37**	99.94**	375.02**
F_2s	44	48.91**	131.81**	99.25**	208.36**	126.22**	104.03**	168.44**	398.44**	187.15**	226.51**	537.63**	199.46**
Parents VsF_2s	1	14.39**	13.60**	82.39**	1870.56**	763.70**	1500.93**	91.26**	348.12**	82.62**	562.837**	896.72**	45.73**
Error	108	2.593	1.044	4.525	1.835	13.693	2.084	40.757	28.597	13.811	15.202	15.955	28.773

Source of Variation	d.f.	No. of tillers per plant			No. of branches per plant			No. of capsules per plant			No. of seeds per capsule		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Replications	2	0.030	13.03	0.661	19.952**	13.399	59.452**	83.282**	6.121	86.783**	0.179**	0.002	0.043
Treatments	54	5.226**	14.16	1.840**	78.435**	102.97**	31.843*	171.317**	381.50**	82.081**	0.77**	0.450**	0.745**
Parents	9	6.21**	15.06	1.912**	22.996**	39.016**	51.631**	279.042**	362.20**	82.73**	0.89**	1.08**	2.91**
F_2s	44	16.03**	13.21	1.766**	199.40**	64.94**	28.205*	52.08**	196.44**	78.08**	1.07**	1.73**	0.72**
Parents VsF_2s	1	5.63**	3.48	9.23**	839.79**	1516.18**	13.80	62.37**	2837.52**	193.113**	2.61**	2.20**	0.78**
Error	108	0.155	9.646	0.668	7.698	15.47	14.394	20.378	11.43	19.841	0.076	0.029	0.031

Table Continue-

Source of Variation	d.f.	1000 seed weight (g.)			Harvest Index (%)			Fibre yield per plant (g.)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Replications	2	0.015	0.040	0.016	1.463	8.171	11.850	0.00002	0.067	0.0666
Treatments	54	1.611**	0.776**	1.594**	24.103**	32.484**	42.860*	1.884**	1.678**	1.592
Parents	9	3.30**	0.681**	1.59**	48.19**	45.89**	41.37*	3.43**	2.19**	3.57**
F_2s	44	1.01**	6.891**	1.60**	53.30**	50.92**	44.14*	2.29**	4.16**	1.15**
Parents VsF_2s	1	1.748**	2.53**	2.04**	39.27**	36.40**	9.44	0.231**	2.44**	3.09**
Error	108	0.026	0.114	0.033	4.018	7.298	17.307	0.015	0.025	0.016

Source of Variation	d.f.	Oil content (%)			Seed yield per plant (g.)		
		L_1	L_2	L_3	L_1	L_2	L_3
Replications	2	1.468	0.144	0.090	0.016	0.030	0.03
Treatments	54	2.778	0.195**	2.571**	6.463**	2.052**	2.425**
Parents	9	5.30**	2.85**	3.35**	10.78**	4.08**	4.18**
F_2s	44	2.38**	3.90**	2.47**	4.01**	4.78**	2.07**
Parents VsF_2s	1	4.59**	5.19**	4.82**	0.084	11.89**	2.60**
Error	108	0.663	0.019	0.108	0.026	0.086	0.040

* Significant at p = 0.05 L_1 = Rath (Hamirpur); L_2 Jabalpur,

** Significant at p = 0.01 L_3 = Kanpur

Table-3 ANOVA for pooled data of Parents, F_1s and F_2 s over three locations for 13 characters in linseed: Mean squares.

Source of Variation	d.f.	Days to 50% flowering		Days to maturity		Plant height (cm.)		Technical plant height (cm.)	
		P+F_1s	P+F_2s	P+F_1s	P+F_2s	P+F_1s	P+F_2s	P+F_1s	P+F_2s
Locations (L)	02	1545.39**	6104.31**	2888.45**	4319.14**	1315.48**	235.46**	883.38**	1387.93**
Replications(R)	02	0.41	2.94	9.46**	28.75	143.70**	7.36	24.25*	61.56**
L×R	04	1.76	8.50**	8.05**	6.60	6.30	29.76	12.99	21.61
Genotypes (G)	54	248.46**	197.68**	111.96**	370.56**	597.18**	444.24**	1086.25**	402.31**
G×L	108	66.81**	75.83**	26.33**	121.23**	152.04**	122.10**	178.68**	85.56**
Error	324	1.88	2.73	2.28	22.20	46.73	27.72	11.22	19.97

Source of Variation	d.f.	No. of tillers per plant		No. of branches per plant		No. of capsules per plant		No.of seeds per capsule	
		P+F_1s	P+F_2s	P+F_1s	P+F_2s	P+F_1s	P+F_2s	P+F_1s	P+F_2s
Locations (L)	02	73.45**	35.82**	12275.52**	8805.05**	34832.26**	28057.06**	250.04**	188.08**
Replications (R)	02	0.31	6.93*	24.76*	20.52	133.40**	135.62**	0.14	0.12**
L×R	04	0.39*	3.39	14.61	36.12**	15.89	20.13	0.05	0.05
Genotypes (G)	54	9.62**	7.99*	385.89**	130.27**	523.31**	164.53**	2.46**	0.71**
G×L	108	2.89**	5.13	74.84**	41.48**	294.31**	235.18**	1.29**	0.62**
Error	324	.18	3.48	12.23	14.18	29.66	17.22	0.39	0.04

Table Contd.....

Source of Variation	d.f.	1000 seed weight (g.)		Harvest Index (%)		Fibre yield per plant (g.)	
		$P+F_1s$	$P+F_2s$	$P+F_1s$	$P+F_2s$	$P+F_1s$	$P+F_2s$
Locations (L)	02	246.35**	94.73**	445.48**	611.24**	5.26**	9.70**
Replications (R)	02	9.68	0.04	0.44	3.98	0.09**	0.08**
L×R	04	9.63	0.01	13.24**	8.68	0.06**	0.02
Genotypes (G)	54	39.25**	1.80**	100.25**	58.29**	9.30**	3.94**
G×L	108	37.15**	1.09**	18.63**	20.57*	0.59*	0.60**
Error	324	9.37	0.06	5.66	9.54	0.03	0.02

Source of Variation	d.f.	Oil Content (%)		Seed yield per plant (g.)	
		$P+F_1s$	$P+F_2s$	$P+F_1s$	$P+F_2s$
Location (L)	02	56.87**	24.65**	25.92**	11.75**
Replications (R)	02	0.33*	0.53	0.21	0.01
L×R	04	0.04	0.66*	0.09	0.02
Genotypes (G)	54	6.10**	4.73**	14.15**	6.54**
G×L	108	1.09**	1.28**	2.01**	2.20**
Error	324	0.016	0.32	0.13	0.06

* Significant at $p = 0.05$ ** Significant at $p = 0.01$

Table- 4: Mean and range of parents, F_1s and F_2s at three locations and pooled over locations in linseed.

Characters	Parents							
	Mean				Range			
	Rath	Jabalpur	Kanpur	Pooled	Rath	Jabalpur	Kanpur	Pooled
Days to 50% flowering	63.63	62.60	71.17	65.70	54.00-84.67	54.67-70.67	58.33-83.67	55.67-79.67
Days to maturity	130.60	124.63	132.70	129.31	121.33-140.33	118.67-132.33	125.33-142.00	121.78-138.22
Plant height (cm)	78.42	77.29	75.69	77.22	56.57-95.67	44.96-94.78	62.05-92.69	54.56-94.38
Tech. plant height (cm)	51.17	51.83	49.72	50.91	35.52-74.22	42.30-62.06	40.13-73.36	39.32-69.88
No. of Tillers/plant	6.01	5.20	4.70	5.30	4.20-8.33	3.65-7.12	3.50-6.18	3.78-7.21
No. of Branches/plant	29.63	22.87	19.49	24.00	24.67-33.67	17..03-28.33	11.73-26.93	17.81-29.64
No. of capsules/plant	77.24	53.58	47.68	59.50	60.00-93.89	39.19-73.23	40.10-54.38	45.76-73.83
No. of seeds/capsule	8.04	6.16	7.64	7.28	7.33-9.09	5.69-7.78	6.60—8.35	6.54-8.41
1000-seed wt. (g)	8.16	6.44	7.85	7.47	6.38-10.00	5.92-7.11	7.04-8.80	6.45-8.64
Harvest index (%)	30.20	26.93	31.33	29.49	24.53-37.93	21.25-33.23	27.20-35.95	24.33-35.70
Fibre yield/plant (g)	1.99	1.83	1.89	1.90	0.78-3.88	0.91-3.08	0.98-3.91	0.89-3.62
Oil content (%)	42.72	41.86	42.43	42.34	40.33-44.86	40.16-43.30	40.60-44.05	40.36-44.07
Seed yield/plant (g)	5.37	4.96	5.66	5.33	2..44-8.31	3.50-7.41	4.17-7.95	3.39-7.89

Table Contd…..

Characters	F_1's							
	Mean				Range			
	Rath	Jabalpur	Kanpur	Pooled	Rath	Jabalpur	Kanpur	Pooled
Days to 50% flowering	64.14	64.18	68.81	65.71	53.33-86.33	55.00-72.33	56.00-79.67	54.78-79.44
Days to maturity	132.33	126.16	134.13	130.87	123.67-141.33	120.33-134.00	127.67-151	123.89-142.11
Plant height (cm)	89.32	82.68	86.06	88.02	75.97-97.37	68.58-96.59	63.89-126.84	69.48-106.93
Tech. plant height(cm)	65.40	63.91	60.30	63.20	42.17-85.90	46.83-88.32	40.91-93.87	43.30-89.36
No. of Tillers/plant	7.02	5.64	6.14	6.27	4.15-10.14	4.14-7.88	3.72-8.25	4.00—8.76
No. of Branches/plant	44.13	38.30	25.60	36.01	34.67-61.67	22.57-56.10	15.87-35.47	24.37-51.08
No. of capsules/plant	89.13	73.55	60.37	74.35	70.13-108.70	47.97-94.48	46.69-76.57	54.93-93.25
No. of seeds/capsule	9.31	6.79	8.52	8.21	8.18-10.52	5.92-8.00	6.93-10.06	7.01-9.53
1000 seed wt. (g)	9.42	7.34	9.88	8.88	8.08-10.95	6.14-8.48	7.67-10.71	7.28-10.05
Harvest index (%)	35.82	33.16	35.74	34.91	31.68-41.51	25.26-39.95	26.83-41.10	27.92-40.85
Fibre yield/plant (g)	3.06	2.67	2.82	2.85	1.10-4.62	1.45-4.70	1.17-4.67	1.24-4.66
Oil content (%)	43.98	42.83	43.80	43.54	41.84-45.20	41.33-44.57	41.57-45.38	41.58-45.05
Seed yield/plant (g)	7.27	6.48	7.11	6.95	3.77-9.68	4.87-10.01	4.83-10.55	4.4-10.08

Table Contd.....

Characters	F$_2$'s							
	Mean				Range			
	Rath	Jabalpur	Kanpur	Pooled	Rath	Jabalpur	Kanpur	Pooled
Days to 50% flowering	64.10	62.46	74.23	66.93	51.67-85.67	56.33-71.00	62.67-85.67	56.89-80.78
Days to maturity	139.67	130.70	140.21	136.86	131.33-152.33	124.33-140.33	128-154.67	127.89-149.11
Plant height (cm)	75.82	78.24	75.79	76.62	48.17-90.80	65.17-92.42	65.43-96.26	59.69-93.16
Tech. Plant height (cm)	54.07	57.70	51.08	54.28	40.53-74.85	43.79-78.64	41.33-75.74	41.88-76.41
No. of Tillers/plant	5.93	5.28	5.13	5.45	3.67-8.75	4.00-7.62	4.01-8.35	3.89-8.24
No. of Branches/plant	35.64	30.64	20.24	28.84	27.33-47.33	20.02-41.01	15.51-29.33	20.95-39.22
No. of capsules/plant	76.17	64.48	50.88	63.84	64.13-93.98	43.79-88.40	43.86-60.28	50.59-80.89
No. of seeds/capsule	8.34	6.24	7.76	7.45	7.43-9.25	5.75-7.21	6.63-8.81	6.60-8.42
1000 seed wt. (g)	7.96	6.77	8.10	7.61	6.79-9.55	6.00—7.16	7.19-10.17	6.66-8.96
Harvest index (%)	31.94	28.40	31.28	30.54	27.68-37.93	21.80-34.48	19.69-36.90	23.06-36.44
Fibre yield/plant (g)	2.04	2.07	1.54	1.88	0.91-3.68	1.11-3.36	1.08-4.12	1.03-3.72
Oil content (%)	42.84	42.09	42.36	42.43	41.41-44.33	40.55-43.56	40.33-44.04	40.76-43.98
Seed yield/plant (g)	5.65	5.46	5.95	5.69	3.16-8.09	3.87-6.92	4.50-7.59	3.84-7.53

Table- 5: Estimates of genetic components of variance and related parameters in F_1 and F_2 generations for various locations and pooled over locations in 10 x 10 diallel cross in linseed.

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	0.65	88.26**	-25.52	63.32**	52.27**	1.88	0.85	0.23	0.71	0.03	-0.2848
	SE		± 2.18	± 7.22	± 16.66	± 15.37	± 13.07	± 8.75					
	L_2	F_1	0.46	23.19**	2.03	29.00**	25.57**	7.90	1.12	0.22	1.08	0.31	-0.7829
	SE		± 1.15	± 3.81	± 8.80	± 8.12	± 6.90	± 4.62					
	L_3	F_1	0.77	52.52**	-9.11	31.46**	20.25**	17.64**	0.77	0.16	0.80	0.87	0.8402
	SE		± 1.24	± 4.11	± 9.49	± 8.75	± 7.44	± 4.98					
Days to 50% flowering	L_1	F_2	0.86	88.05**	-25.83	300.34**	272.12**	1.57	1.85	0.23	0.85	0.01	-0.1523
	SE		± 2.23	± 7.40	± 34.16	± 63.03	± 53.57	± 8.96					
	L_2	F_2	0.35	23.30**	13.58	53.67*	47.97*	-0.06	1.52	0.22	1.48	0.001	0.3012
	SE		± 0.83	± 2.74	± 12.66	± 23.37	± 19.86	± 3.32					
	L_3	F_2	1.51	51.78**	42.17	303.12**	248.39**	30.00*	2.42	0.20	1.40	0.12	-0.7537
	SE		± 3.13	± 10.38	± 47.88	± 88.35	± 75.09	± 12.56					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	0.60	28.60**	1.04	11.00**	10.49**	9.52**	0.62	0.24	1.06	0.91	0.4206
	SE		± 0.36	± 1.19	± 2.74	± 2.53	± 2.15	± 1.44					
	L_2	F_1	0.85	14.62**	1.22	10.11**	8.76**	7.20**	0.83	0.22	1.11	0.82	0.2236
	SE		± 0.49	± 1.62	± 3.75	± 3.46	± 2.94	± 1.97					
	L_3	F_1	0.83	30.14**	-6.88	42.19**	38.05**	6.36	1.18	0.23	0.82	0.17	0.6913
	SE		± 2.19	± 7.27	± 16.78	± 15.48	± 13.15	± 8.81					
Days to maturity	L_1	F_2	0.61	28.59**	-31.44	327.03**	240.48**	266.56**	3.38	0.18	0.72	1:11	-0.8944
	SE		± 1.52	± 5.04	± 23.24	± 42.89	± 36.45	± 6.10					
	L_2	F_2	20.90	5.43	-117.01	1397.81	1304.52	111.87	16.04	0.23	0.20	0.09	-0.4368
	SE		± 40.75	± 135.14	± 623.63	±1150.66	± 977.93	± 163.65					
	L_3	F_2	0.69	30.28**	-35.73	251.02**	211.61**	182.36**	2.88	0.21	0.66	0.86	-0.8446
	SE		± 1.91	± 6.34	± 29.26	± 53.99	± 45.89	± 7.68					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
Plant height (cm)	L_1	F_1	9.70**	167.92**	80.78**	99.43**	88.00**	381.40**	0.77	0.23	1.91	4.33	-0.9750
	SE		± 2.37	± 7.85	± 18.12	± 16.71	± 14.21	± 9.51					
	L_2	F_1	19.52**	159.51**	129.85**	96.90**	58.28	87.08**	0.78	0.15	3.19	1.49	-0.8586
	SE		± 5.31	± 17.60	± 40.60	± 37.46	± 31.84	± 21.31					
	L_3	F_1	17.51	79.15*	-111.56	188.82*	172.28**	323.90**	1.54	0.23	0.37	1.88	0.6148
	SE		± 10.93	± 36.26	± 83.67	± 77.19	± 65.61	± 43.91					
	L_1	F_2	13.59**	164.04**	-31.98	257.12*	278.42**	17.06	1.25	0.27	0.86	0.06	0.5546
	SE		± 4.54	± 15.04	± 69.42	± 128.09	± 108.86	± 18.22					
	L_2	F_2	9.53**	169.51**	238.98**	147.88**	54.01**	-0.41	0.93	0.09	7.15	-0.01	-0.5983
	SE		± 0.55	± 1.83	± 8.49	± 15.66	± 13.31	± 2.23					
	L_3	F_2	4.60	92.06**	-2.09	335.40**	329.09**	-1.55	1.91	0.25	0.99	0.00	0.5684
	SE		± 4.59	± 15.24	± 70.32	± 129.74	± 110.27	± 18.45					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
Technical plant height (cm)	L_1	F_1	4.96	151.17**	-50.04	210.62**	167.16**	654.65**	1.18	0.20	0.75	3.92	-0.9544
	SE		± 4.00	± 13.25	± 30.58	± 28.21	± 23.98	± 16.05					
	L_2	F_1	2.21	31.11	-40.17	183.62**	158.23**	472.31**	2.43	0.22	0.58	2.98	0.2882
	SE		± 5.26	± 17.44	± 40.23	± 37.11	± 31.54	± 21.11					
	L_3	F_1	4.06	120.95	-97.02	489.22*	416.15*	361.64**	2.01	0.21	0.67	0.87	0.0649
	SE		± 33.87	± 122.33	± 295.18	± 239.11	± 203.22	± 136.03					
	L_1	F_2	5.07	151.06**	181.23**	447.49**	301.41**	25.43	1.72	0.17	2.07	0.08	0.6150
	SE		± 3.38	± 11.21	± 51.73	± 95.44	± 81.12	± 13.57					
	L_2	F_2	5.32	28.00**	-43.76	272.82**	256.35**	109.63**	3.12	0.23	0.60	0.43	-0.0289
	SE		± 2.83	± 9.37	± 43.26	± 79.82	± 67.84	± 11.35					
	L_3	F_2	9.59	115.42**	43.00	388.61	377.46*	2.62	1.83	0.24	1.23	0.01	-0.1032
	SE		± 7.03	± 23.30	± 107.54	± 198.42	± 168.63	± 28.22					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	0.05	2.02**	-0.66	6.65**	6.31**	3.33**	1.81	0.24	0.83	0.53	-0.3601
	SE		± 0.10	± .34	± 0.78	± 0.72	± 0.61	± 0.41					
	L_2	F_1	0.10	1.58**	0.48	2.07**	1.92**	0.59	1.14	0.23	1.31	0.31	-0.2513
	SE		± 0.11	± 0.36	± 0.84	± 0.77	± 0.66	± 0.44					
	L_3	F_1	0.04	0.60*	-0.45	2.14**	1.82**	6.75**	1.89	0.21	0.67	3.70	-0.6957
	SE		± 0.07	± 0.24	± 0.56	± 0.51	± 0.44	± 0.29					
No. of tillers per plant	L_1	F_2	0.05	2.02**	0.30	14.02**	13.09**	0.001	2.64	0.23	1.06	0.00	-0.0741
	SE		± 0.09	± 0.31	± 1.43	± 2.63	± 2.24	± 0.37					
	L_2	F_2	3.22*	1.53	-6.86	26.39	30.16	-1.14	4.15	0.29	0.30	-0.04	-0.2266
	SE		± 1.61	± 5.34	± 24.63	± 45.44	± 38.62	± 6.46					
	L_3	F_2	0.22**	0.41	-0.64	2.77	3.05	0.51	2.59	0.27	0.54	0.17	0.0820
	SE		± 0.08	± 0.28	± 1.27	± 2.34	± 1.99	± 0.33					

Table 5 : Contd….

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
No. of branches per plant	L_1	F_1	2.14	5.53	-17.43	196.43**	175.58**	680.44**	5.96	0.22	0.58	3.88	-0.0989
	SE		± 6.77	± 22.46	± 51.82	± 47.80	± 40.63	± 27.20					
	L_2	F_1	4.08	8.93	-30.98	213.70**	190.75**	770.06**	4.89	0.22	0.48	4.04	0.2269
	SE		± 4.56	± 15.12	± 34.89	± 32.19	± 27.36	± 18.31					
	L_3	F_1	6.62**	10.59**	-12.66	27.95**	30.18**	118.50**	1.62	0.27	0.46	3.93	-0.5770
	SE		± 1.11	± 3.68	± 8.48	± 7.83	± 6.65	± 4.45					
	L_1	F_2	2.57	5.10	-19.75	261.44**	224.87**	116.15**	7.16	0.22	0.57	0.52	-0.1345
	SE		± 2.87	± 9.53	± 43.96	± 81.11	± 68.93	± 11.54					
	L_2	F_2	5.16**	7.85	-41.41	265.97**	250.64**	193.54**	5.82	0.24	0.38	0.77	0.1033
	SE		± 1.64	± 5.44	± 25.13	± 46.36	± 39.40	± 6.59					
	L_3	F_2	6.46**	10.75**	-14.04	15.89	-3.12	-0.50	1.14	0.05	0.30	0.16	0.5650
	SE		± 0.48	± 1.61	± 7.41	± 13.68	± 11.62	± 1.95					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	15.96**	77.06**	-40.25	155.42**	158.40**	451.97**	1.42	0.25	0.69	2.85	-0.9167
	SE		± 4.02	± 13.33	± 30.75	± 28.37	± 24.11	± 16.14					
	L_2	F_1	6.69	114.04**	-57.63	355.00**	338.86**	1289.81**	1.76	0.24	0.75	3.81	-0.7766
	SE		± 8.64	± 28.67	± 66.15	± 61.02	± 51.86	± 34.72					
	L_3	F_1	7.02*	20.56*	-3.09	220.23**	204.21**	519.24**	3.27	0.23	0.96	2.54	-0.6336
	SE		± 3.19	± 10.59	± 24.44	± 22.54	± 19.16	± 12.82					
No. of capsules per plant	L_1	F_2	6.79**	86.22**	50.57	317.89**	242.41**	1.28	1.92	0.19	1.36	0.01	0.5798
	SE		± 2.49	± 8.26	± 38.12	± 70.34	± 59.78	± 10.00					
	L_2	F_2	3.81	116.92**	-100.93	635.16**	553.26**	383.87**	2.33	0.22	0.69	0.69	-0.4407
	SE		± 4.96	± 16.46	± 75.97	± 140.16	± 119.12	± 19.93					
	L_3	F_2	6.61**	20.97**	-5.76	211.11**	208.71**	30.92**	3.17	0.25	0.92	0.15	0.0064
	SE		± 1.42	± 4.70	± 21.67	± 39.99	± 33.99	± 5.69					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	0.04	0.26*	0.07	1.36**	1.36**	5.19**	2.29	0.25	1.12	3.81	-0.7456
	SE		± 0.04	± 0.12	± 0.27	± 0.25	± 0.22	± 0.14					
	L_2	F_1	0.01	0.35**	0.20	0.59**	0.48**	1.29**	1.30	0.20	1.56	2.71	-0.8357
	SE		± 0.02	± 0.07	± 0.15	± 0.14	± 0.12	± 0.08					
	L_3	F_1	0.34**	0.24	0.51	1.24*	1.38**	2.39**	2.27	0.28	2.50	1.73	0.2006
	SE		± 0.07	± 0.23	± 0.52	± 0.48	± 0.41	± 0.27					
No. of seeds per capsule	L_1	F_2	0.03**	0.27**	0.16	2.24**	1.93**	0.28**	2.87	0.22	1.23	0.14	0.3481
	SE		± 0.01	± 0.03	± 0.13	± 0.24	± 0.20	± 0.03					
	L_2	F_2	0.01	0.35**	0.59**	1.35**	0.94**	0.02	1.96	0.17	2.51	0.02	0.9095
	SE		± 0.01	± 0.03	± 0.13	± 0.23	± 0.20	± 0.03					
	L_3	F_2	0.01	0.29**	0.07	1.34**	1.12**	0.05	2.14	0.21	1.13	0.04	0.5873
	SE		± 0.01	± 0.03	± 0.15	± 0.27	± 0.23	± 0.04					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	0.01	1.08**	0.38	1.32**	1.16**	5.17**	1.10	0.22	1.38	4.46	-0.9562
	SE		± 0.03	± 0.09	± 0.22	± 0.20	± 0.17	± 0.11					
	L_2	F_1	0.04**	0.19**	0.01	0.75**	0.68**	2.62**	1.97	0.23	1.02	3.84	-0.6620
	SE		± 0.01	± 0.05	± 0.11	± 0.10	± 0.09	± 0.06					
	L_3	F_1	9.32	8.79	13.16	135.55	127.62	10.00	3.93	0.24	1.47	0.08	-0.3262
	SE		± 18.84	± 62.49	± 144.18	± 133.01	± 113.05	± 75.67					
1000-seed weight (g)	L_1	F_2	0.01	1.09**	0.89**	2.54**	1.81**	0.13	1.53	0.18	1.73	0.07	0.9344
	SE		± 0.02	± 0.06	± 0.28	± 0.52	± 0.44	± 0.07					
	L_2	F_2	0.04*	0.19*	0.10	2.09**	2.00**	0.35**	3.32	0.24	1.17	0.17	-0.3355
	SE		± 0.02	± 0.08	± 0.35	± 0.64	± 0.55	± 0.09					
	L_3	F_2	0.01	0.52*	0.26	5.33*	4.62*	0.20	3.20	0.22	1.17	0.04	-0.1142
	SE		± 0.08	± 0.26	± 1.21	± 2.23	± 1.90	± 0.32					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	1.68**	14.38**	0.76	14.52**	13.04**	102.55**	1.00	0.22	1.05	7.86	-0.9624
	SE		± 0.32	± 1.08	± 2.48	± 2.29	± 1.95	± 1.30					
	L_2	F_1	2.14**	13.16**	-3.72	29.41**	27.56**	124.90**	1.49	0.23	0.83	4.53	-0.9584
	SE		± 0.65	± 2.16	± 4.99	± 4.60	± 3.91	± 2.62					
	L_3	F_1	1.84**	11.95**	-6.62	13.82**	14.14**	62.39**	1.08	0.26	0.59	4.41	-0.9332
	SE		± 0.45	± 1.51	± 3.48	± 3.21	± 2.73	± 1.83					
Harvest index (%)	L_1	F_2	1.34**	14.72**	11.33*	36.24**	33.33**	9.54**	1.57	0.23	1.65	0.29	0.2883
	SE		± 0.32	± 1.06	± 4.88	± 9.00	± 7.65	± 1.28					
	L_2	F_2	2.43**	12.86**	-7.38	27.22*	29.67**	6.16**	1.45	0.27	0.67	0.21	-0.5269
	SE		± 0.42	± 1.40	± 6.45	± 11.90	± 10.12	± 1.69					
	L_3	F_2	5.77**	8.02	-19.37	57.38	59.53	-2.07	2.67	0.26	0.38	-0.03	0.1837
	SE		± 1.62	± 5.37	± 24.76	± 45.68	± 38.82	± 6.50					

Table 5 : Contd....

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	0.01	1.14**	-0.50*	1.22**	1.07**	3.73**	1.03	0.22	0.65	3.48	-0.9774
	SE		± 0.03	± 0.09	± 0.20	± 0.19	± 0.16	± 0.11					
	L_2	F_1	0.01	0.72**	-0.31	1.18**	1.09**	2.29**	1.28	0.23	0.71	2.11	-0.6370
	SE		± 0.04	± 0.13	± 0.29	± 0.27	± 0.23	± 0.15					
	L_3	F_1	0.01	1.18**	-1.15**	1.62**	1.30**	2.75**	1.17	0.20	0.41	2.12	-0.9482
	SE		± 0.03	± 0.09	± 0.22	± 0.20	± 0.17	± 0.11					
Fibre yield per plant (g)	L_1	F_2	0.00	1.14**	0.30	2.15**	2.02**	0.01	1.38	0.23	1.22	0.00	0.5889
	SE		± 0.01	± 0.04	± 0.16	± 0.30	± 0.26	± 0.04					
	L_2	F_2	0.01	0.72**	0.08	3.47**	3.00**	0.19	2.19	0.22	1.05	0.06	0.0082
	SE		± 0.02	± 0.08	± 0.37	± 0.69	± 0.59	± 0.10					
	L_3	F_2	0.01	1.19**	1.22**	3.07**	2.66**	0.40**	1.61	0.22	1.94	0.15	0.9832
	SE		± 0.02	± 0.06	± 0.29	± 0.53	± 0.45	± 0.08					

Table 5 : Contd….

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	0.07	1.40**	0.84**	1.52**	1.17**	5.13**	1.04	0.22	1.78	4.39	-0.8552
	SE		± 0.04	± 0.12	± 0.28	± 0.26	± 0.22	± 0.15					
	L_2	F_1	0.06*	0.89**	0.25	1.47**	1.35**	2.85**	1.28	0.23	1.25	2.11	-0.3833
	SE		± 0.03	± 0.11	± 0.25	± 0.23	± 0.20	± 0.13					
	L_3	F_1	0.05	1.07**	0.60	2.56**	2.23**	6.04**	1.55	0.22	1.45	2.71	-0.8744
	SE		± 0.05	± 0.18	± 0.41	± 0.38	± 0.33	± 0.22					
Oil content (%)	L_1	F_2	0.22**	1.55**	1.18	4.64*	4.14*	-0.03	1.73	0.22	1.56	-0.01	0.5500
	SE		± 0.08	± 0.26	± 1.20	± 2.22	± 1.88	± 0.32					
	L_2	F_2	0.06*	0.89**	0.14	3.49**	3.23**	0.12	1.98	0.23	1.08	0.04	0.2857
	SE		± 0.03	± 0.10	± 0.45	± 0.83	± 0.70	± 0.12					
	L_3	F_2	0.04	1.08**	0.55	3.15**	2.80**	0.00	1.71	0.22	1.35	0.00	06112
	SE		± 0.04	± 0.12	± 0.57	± 1.05	± 0.89	± 0.15					

Table 5 : Contd….

Character	Location	Generation	$\hat{E}$	$\hat{D}$	$\hat{F}$	$\hat{H}_1$	$\hat{H}_2$	$\hat{h}^2$	$(\hat{H}_1/\hat{D})^{1/2}$	$\hat{H}_2/4\hat{H}_1$	KD/KR	$\hat{h}^2/\hat{H}_2$	r
	L_1	F_1	0.07	3.12**	0.45	3.21**	2.81**	11.69**	1.02	0.22	1.14	4.16	-0.9872
	SE		± 0.04	± 0.14	± 0.33	± 0.31	± 0.26	± 0.18					
	L_2	F_1	0.05	1.31**	0.47	2.42**	2.07**	7.52**	1.36	0.21	1.30	3.64	-0.6775
	SE		± 0.08	± 0.26	± 0.60	± 0.55	± 0.47	± 0.31					
	L_3	F_1	0.02	1.37**	0.29	3.73**	3.25**	6.84**	1.65	0.22	1.13	2.10	-0.8474
	SE		± 0.10	± 0.34	± 0.78	± 0.72	± 0.61	± 0.41					
Seed yield per plant (g.)	L_1	F_2	0.02	3.57**	0.38	7.03**	5.78**	0.25	1.40	0:21	1.08	0.04	0.1649
	SE		± 0.04	± 0.13	± 0.61	± 1.13	± 0.96	± 0.16					
	L_2	F_2	0.03	1.33**	1.04**	3.08**	2.29**	0.81**	1.52	0.19	1.69	0.35	-0.3235
	SE		± 0.02	± 0.06	± 0.29	± 0.54	± 0.46	± 0.08					
	L_3	F_2	0.01	1.38**	1.41**	6.80**	5.94**	0.27**	2.22	0.22	1.60	0.04	0.4859
	SE		± 0.03	± 0.09	± 0.39	± 0.73	± 0.62	± 0.10					

* Significant at p = 0.05 ** Significant at p = 0.01 L_1: Rath; L_2: Jabalpur; L_3: Kanpur

Table 6(a) : Analysis of variance for combining ability in F_1 generation over locations in 10 x 10 diallel cross in linseed : Mean square

Source of variation	d.f	Days to 50% flowering			Days to maturity			Plant height (cm)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
GCA	9	341.651**	71.943**	204.203**	84.628**	44.179**	116.763**	332.091**	247.401**	562.495**
SCA	45	15.244**	7.145**	6.885**	3.253**	2.973**	10.501**	38.169**	31.229	62.708**
Error	108	0.652	0.458	0.768	0.602	0.851	0.832	9.698	14.525	17.508
σ^2gca		28.417	5.957	16.953	7.002	3.611	9.680	26.866	18.990	45.416
σ^2sca		14.592	6.687	6.117	2.651	2.122	9.670	28.471	11.704	45.200
GPR		0.796	0.640	0.847	0.841	0.772	0.666	0.654	0.764	0.667

Source of variation	d.f	Technical plant height (cm.)			No. of tillers/ plant			No. of branches / plant		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
GCA	9	672.463**	248.098**	760.333**	8.460**	3.917**	3.624**	105.148**	154.773**	63.182**
SCA	45	64.799**	54.873**	121.596**	1.717**	0.568**	0.674**	64.051**	71.395**	14.163*
Error	108	4.960	2.208	4.060	0.046	0.105	0.038	2.137	4.080	6.621
σ^2gca		55.625	20.491	63.023	0.701	0.318	0.299	8.584	12.558	4.713
σ^2sca		59.839	52.665	117.536	1.671	0.463	0.636	61.914	67.315	7.542
GPR		0.650	0.438		0.456	0.579	0.485	0.217	0.272	0.555

Table Contd....

Source of variation	d.f	No. of capsules/plant			No. of seeds/capsule			1000-seed weight (g)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
GCA	9	336.210**	524.288**	107.474**	0.971**	1.777**	1.081**	2.650**	0.751**	29.282**
SCA	45	59.954**	122.482**	69.539**	0.493**	0.169**	0.590*	0.442**	0.262**	38.186**
Error	108	15.955	6.691	7.017	0.039	0.014	0.243	0.014	0.036	9.324
σ^2gca		26.688	43.13	8.371	0.078	0.147	0.062	0.220	0.060	1.663
σ^2sca		44.00	115.791	62.522	0.454	0.155	0.247	0.428	0.226	28.862
GPR		0.548	0.427	0.211	0.260	0.655	0.334	0.507	0.347	0.103

Source of variation	d.f	Harvest index (%)			Fibre yield (g)			Oil content (%)			Seed yield/plant (g)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
GCA	9	45.435**	54.072**	52.950**	4.971**	3.129**	7.096**	3.352**	2.344**	2.410**	10.316**	5.861**	5.842**
SCA	45	6.942**	11.428**	6.145**	0.378**	0.345**	0.427**	0.476**	0.450**	0.765**	1.069**	0.766**	1.038**
Error	108	1.683	2.135	1.844	0.006	0.014	0.010	0.072	0.055	0.046	0.066	0.051	0.021
σ^2gca		3.646	4.328	4.259	0.414	0.260	0.591	0.273	0.191	0.197	0.854	0.484	0.485
σ^2sca		5.259	9.293	4.301	0.372	0.331	0.417	0.404	0.395	0.719	1.003	0.715	1.018
GPR		0.581	0.482	0.664	0.690	0.611	0.740	0.574	0.492	0.354	0.630	0.575	0.488

*** Significant at $p = 0.05$ ** Significant at $p = 0.01$ L_1 Rath; L_2 : Jabalpur; L_3 Kanpur**

Table-6 (b): Analysis of Variance for combining ability in F_2 generation over locations in 10×10 diallel cross in linseed: Mean squares.

Source of variation	d.f.	Days to 50% flowering			Days to maturity			Plant height (cm.)			Technical plant height (cm.)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
GCA	9	311.706**	56.124**	132.153**	170.539**	192.478**	156.484**	530.062**	265.011**	285.127**	306.106**	150.806**	304.701**
SCA	45	18.135**	3.316**	18.290**	29.919**	98.333**	19.052**	25.20*	10.811**	23.311**	25.439**	22.196**	29.412**
Error	108	0.864	0.348	1.508	0.611	20.898	0.695	11.585	5.532	4.604	5.067	5.318	9.591
σ^2gca		25.903	4.648	10.887	14.161	14.298	12.982	43.039	21.620	23.377	25.086	12.124	24.592
σ^2sca		17.269	2.698	16.782	23.308	77.435	18.357	13.624	5.279	18.707	20.372	16.878	19.821
GPR		0.750	0.758	0.565	0.548	0.270	0.586	0.881	0.971	0.714	0.711	0.590	0.0.713

Source of variation	d.f.	No. of Tillers per plant			No. of branches per plant			No. of capsules per plant		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
GCA	9	6.196**	4.178**	2.052**	60.735**	86.731**	47.455**	139.299**	522.128**	75.748**
SCA	45	0.867**	3.630**	0.326**	19.226**	23.841**	32.841**	20.665**	48.171**	17.683**
Error	108	0.051	1.215	0.123	2.566	5.156	6.465	6.792	3.810	6.614
σ^2gca		0.512	0.247	0.160	4.487	6.798	3.415	11.042	43.193	5.761
σ^2sca		0.816	2.415	0.203	16.660	18.685	26.016	13.873	44.361	11.069
GPR		0.556	0.278	0.747	0.368	0.421	0.208	0.723	0.661	0.510

Table Contd...

Source of variation	d.f.	No. of seed per capsule			1000 seed weight (g.)			Harvest index (%)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
GCA	9	0.795**	0.533**	0.681**	1.537**	0..765**	1.613**	22.425**	23.163**	51.00**
SCA	45	0.148**	0.073**	0.082**	0.136**	0.157**	0.315**	3.155**	3.360*	6.945**
Error	108	0.025	0.009	0.010	0.008	0.038	0.01	1.339	1.430	2.769
σ^2gca		0.064	0.044	0.056	0.127	0.060	0.133	1.757	1.811	4.019
σ^2sca		0.123	0.064	0.671	1.529	0.119	0.304	1.816	1.930	4.176
GPR		0.510	0.579	0.712	0.767	0.502	0.467	0.740	0.891	0.865

Source of variation	d.f.	Fibre yield per plant (g.)			Oil Content %			Seed yield per plant (g.)		
		L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
GCA	9	3.108**	2.320**	2.244**	3.580**	2.667**	4.127**	10.900**	3.120**	2.833**
SCA	45	0.132**	0.207**	0.188**	0.396**	0.246**	0.203**	0.405**	0.197**	0.404**
Error	108	0.005	0.008	0.005	0.121	0.063	0.036	0.020	0.029	0.013
σ^2gca		0.260	0.193	0.186	0.280	0.217	0.341	0.907	0.257	0.235
σ^2sca		0.127	0.199	0.183	0.175	0.183	0.1637	0.385	0.168	0.391
GPR		0.803	0.660	0.670	0.762	0.703	0.803	0.825	0.754	0.546

* Significant at $p = 0.05$ ** Significant at $p = 0.01$ L_1: Rath; L_2: Jabalpur; L_3: Kanpur

Table - 7 : Pooled analysis of variance for Parents+F_1s and Parents+F_2s for combining ability for 13 characters in linseed: Mean squares.

Source of Variation	d.f.	Days to 50% flowering		Days to maturity		Plant height (cm)		Tech. plant height (cm)		No. of tillers/plant		No. of branches/plant		No. of capsules/ plant	
		F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Location	2	515.11**	2034.71**	963.14**	1440.97**	439.00**	78.43**	294.15**	462.34**	24.48**	11.94**	4091.93**	2935.10**	11610.54**	9352.35**
GCA	9	440.03**	32.91**	188.60**	393.66**	835.69**	803.98**	1392.70**	640.45**	12.58**	8.42**	249.14**	137.58**	181.58**	155.12**
SCA	45	11.38**	13.49**	7.07**	69.54**	71.75**	16.90**	155.94**	32.82**	1.33**	1.51**	104.53**	24.60**	173.80**	34.79**
GCA x L	18	88.88**	86.04**	28.48**	62.92**	153.15**	138.11**	144.09**	60.58**	1.71**	2.00**	36.98**	28.67**	393.20**	341.03**
SCA X L	90	8.95**	12.12**	4.83**	35.88**	30.18**	21.22**	42.66**	22.12**	0.81**	1.65**	22.54**	10.86**	39.09**	25.87**
Error	324	0.63	0.91	0.76	7.40	15.58	9.24	3.75	6.66	0.06	0.16	4.28	4.73	9.89	5.74
$\hat{\delta}^2_{l+}$	-	6.54	35.32	16.63	24.65	3.34	-2.85	1.19	6.72	0.40	0.17	73.36	52.58	198.59	159.07
$\hat{\delta}^2_{g++}$	-	9.73	6.71	4.42	8.88	18.58	18.54	33.63	16.01	3.55	0.18	5.14	2.90	-7.12	-5.24
$\hat{\delta}^2_s$	-	0.81**	0.12**	0.75**	11.22**	13.86**	-1.44**	37.96**	3.57**	0.17**	0.05**	27.36**	4.58**	44.90**	2.97**
$\hat{\delta}^2_{gl}$	-	6.66**	6.08**	1.98**	2.25**	10.24**	09.74**	8.45**	3.21**	0.08**	0.03**	1.20**	1.48**	29.51**	26.26**
$\hat{\delta}^2_{sl}$	-	8.32**	12.21**	4.07**	28.48**	14.60**	11.98**	38.91**	15.46**	0.75**	0.49**	18.26**	6.13**	29.20**	20.13**
$\hat{\delta}^2_g + \hat{\delta}^2_s$	-	10.54	6.63	5.17	20.10	32.44	17.10	71.39	19.58	4.72	0.23	32.40	7.48	37.78	-2.27
$\hat{\delta}^2_{gl} + \hat{\delta}^2_{sl}$	-	14.98	18.29	6.05	30.73	24.84	21.72	47.36	18.67	0.83	0.52	19.46	7.61	58.71	46.39
$\hat{\delta}^2_g/(\hat{\delta}^2_g + \hat{\delta}^2_s)$	-	0.92	0.98	0.85	0.44	0.57	1.08	0.47	0.82	0.75	0.78	0.16	0.39	-0.19	2.31
$\hat{\delta}^2_g/(\hat{\delta}^2_g+\hat{\delta}^2_{gl})$	-	0.59	0.52	0.69	0.80	0.64	0.66	0.80	0.83	0.98	0.86	0.81	0.66	-0.32	-0.25
$\hat{\delta}^2_s/(\hat{\delta}^2_s + \hat{\delta}^2_{sl})$	-	0.09	0.01	0.15	0.28	0.49	-0.14	0.49	0.10	0.18	0.09	0.60	0.43	0.61	0.13

Table - 7 : Contd.......

Source of Variation	d.f.	No. of seeds/capsule		1000-seed weight (g)		Harvest index (%)		Fibre yield (g)		Oil content (%)		Seed yield/plant (g)	
		F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Location	2	83.35**	62.69**	88.11**	315.72**	148.60**	203.83**	1.75**	3.23**	18.94**	8.19**	8.63**	3.91**
GCA	9	1.40**	0.87**	9.05**	2.52**	106.23**	92.01**	14.11**	7.07**	6.66**	7.72**	18.67**	10.99**
SCA	45	0.71**	0.11**	13.89**	0.22**	18.86**	4.92**	0.90**	0.16**	1.11**	0.35**	1.93**	0.42**
GCA x L	18	1.22**	0.77**	11.82**	1.20**	23.11**	19.79**	0.54**	0.30**	0.72**	1.33**	1.67**	2.93**
SCA X L	90	0.27**	0.09**	12.50**	0.20**	2.83**	4.27**	0.13**	0.18**	0.30**	0.25**	0.47**	0.29**
Error	324	0.13	0.01	3.12	0.02	1.89	3.18	0.009	0.006	0.06	0.11	0.05	0.02
$\hat{\delta^2 l}+$	-	1.48	1.11	1.39	5.70	1.97	3.11	0.01	0.05	0.33	0.10	0.11	-0.02
$\hat{\delta^2 g}++$	-	0.00	0.00	0.09	0.04	2.16	2.00	0.37	0.19	0.16	0.17	0.46	0.22
$\hat{\delta^2 s}$	-	0.15	0.01	0.46**	0.01	5.34**	0.22	0.26**	-0.01	0.27**	0.03	0.49**	0.04*
$\hat{\delta^2 gl}$	-	0.08**	0.06	-0.06	0.08**	1.69**	1.29**	0.04**	0.01	0.03	0.10	0.10*	0.22**
$\hat{\delta^2 sl}$	-	0.14	0.08**	9.38**	0.18**	0.94	1.09**	0.12**	0.17**	0.24**	0.14	0.42**	0.27**
$\hat{\delta^2 g} + \hat{\delta^2 s}$	-	0.15	0.01	0.55	0.05	7.50	2.22	0.63	0.18	0.43	0.20	0.95	0.26*
$\hat{\delta^2 gl} + \hat{\delta^2 sl}$	-	0.22	0.14	9.32	0.26	2.63	2.38	0.16	0.18	0.27	0.24	0.52	0.49
$\hat{\delta^2 g}/(\hat{\delta^2 g} + \hat{\delta^2 s})$	-	0.00	0.00	0.16	0.80	0.29	0.90	0.59	1.05	0.37	0.85	0.48	0.85
$\hat{\delta^2 g}/(\hat{\delta^2 g} + \hat{\delta^2 gl})$	-	0.00	0.00	3.00	0.33	0.56	0.61	0.90	0.95	0.84	0.63	0.82	0.50
$\hat{\delta^2 s}/(\hat{\delta^2 s} + \hat{\delta^2 sl})$	-	0.52	0.11	0.05	0.05	0.85	0.17	0.68	-0.06	0.53	0.18	0.54	0.13

Table -8 : Estimates of gca effects of parents and corresponding mean performance over locations and pooled over locations in F_1 and F_2 generations in 10 x 10 diallel cross in linseed.

Days to 50 per cent flowering

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	65.00	68.67	74.00	69.22	0.14	2.46**	1.86**	1.49**	-0.10	2.25**	1.07**	1.07**
Shubhra	64.00	61.00	77.00	67.33	-0.08	-1.29**	3.03**	0.55**	0.37	-0.89**	0.54	0.01
Sweta	56.33	54.67	67.62	57.89	-3.24**	-2.29**	-4.86**	-3.46**	-2.60**	-4.14**	-2.09**	-2.94**
LMH-62	53.67	56.33	58.33	56.11	-4.74**	-3.32**	-9.19**	-5.75**	-4.68**	-2.64**	-5.07**	-4.13**
DPL-21	84.67	70.67	83.67	79.67	12.78**	5.10**	4.44**	7.44**	12.29**	3.14**	6.04**	7.16**
J-23	54.00	64.67	72.33	63.67	-5.05**	1.18**	1.47**	-0.80**	-5.02**	1.06**	2.35**	-0.54**
RLC-6	65.67	63.33	69.33	66.11	0.56*	0.18	1.22**	0.66**	0.04	1.08**	-0.93**	0.06
Garima	55.33	62.00	67.67	61.67	-3.77**	-0.32	-1.31**	-1.80**	-3.13**	0.00	-2.07**	-1.73**
KL-43	69.67	63.00	70.33	67.67	4.34**	-0.15	0.75**	1.65**	4.15**	0.03	-3.12**	0.35**
LCK-88062	65.00	61.67	76.33	67.67	0.94**	-1.57**	2.58**	0.03	-1.32**	0.11	3.27**	0.69**
SE (m) ±	**1.14**	**0.96**	**1.24**	**0.65**								
SE (gi) ±					**0.22**	**0.18**	**0.24**	**0.13**	**0.25**	**0.16**	**0.34**	**0.15**
SE (gi-gj) ±					**0.33**	**0.28**	**0.36**	**0.19**	**0.38**	**0.24**	**0.50**	**0.22**

Table Contd....

Days to maturity

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	130.67	126.33	138.00	131.67	0.46*	-0.31	3.31**	1.15**	-1.49**	0.26	3.20**	0.65
Shubhra	129.67	122.33	132.00	128.00	-0.88**	-0.44	0.09	-0.41**	-1.11**	-0.22	-2.83**	-1.38**
Sweta	132.33	124.67	127.33	128.11	0.76**	-0.19	-2.77**	-0.74**	-0.13	-0.44	-3.66**	-1.41**
LMH-62	121.33	118.67	125.33	121.78	-4.71**	-3.17**	-3.83**	-3.90**	-2.77**	-7.14**	-2.52**	-4.35**
DPL-21	140.33	128.33	142.00	136.89	4.54**	2.39**	3.34**	3.42**	8.53**	4.17**	6.39**	6.37**
J-23	123.33	124.00	135.00	127.44	-3.02**	-0.50*	1.17**	-0.78**	-3.58**	0.34	0.48*	-0.92*
RLC-6	130.00	120.00	125.67	125.22	-0.66**	-2.31**	-4.83**	-2.60**	-2.61**	-0.38	-4.49**	-2.49**
Garima	130.33	124.33	131.67	128.78	-0.66**	0.39	-1.05**	-0.44**	-2.38**	-4.52**	-0.91**	-2.61**
KL-43	133.00	132.33	137.67	134.33	1.57**	3.25**	4.14**	2.99**	1.48**	6.45**	4.14**	4.02**
LCK-88062	135.00	125.33	132.33	130.89	2.59**	0.89**	0.42	1.30	4.06**	2.09	0.20	2.12
SE (m) ±	**1.09**	**1.300**	**1.29**	**0.71**								
SE (gi) ±					**0.21**	**0.25**	**0.25**	**0.13**	**0.21**	**1.25**	**0.23**	**0.43**
SE (gi-gj) ±					**0.32**	**0.38**	**0.37**	**0.21**	**0.32**	**1.87**	**0.34**	**0.64**

Table Contd….

Plant height (cm.)

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	93.23	89.16	84.97	89.12	6.66**	6.29**	3.17**	5.37**	6.26**	5.94**	4.63**	5.61**
Shubhra	80.57	74.50	62.05	72.37	0.06	-1.52	-8.82**	-3.43**	1.71	-1.08	-5.15**	-1.50**
Sweta	72.57	82.1e6	69.72	74.82	-1.89*	3.15**	-4.55*	-1.10	-2.06**	2.36**	-2.36**	-0.69
LMH-62	58.33	44.967	67.16	56.82	-6.66**	-8.32**	-5.35**	-6.78**	-10.95**	-10.60**	-4.88**	-8.81**
DPL-21	95.67	83.27	92.69	90.54	8.40**	2.56*	12.70**	7.89*	7.84**	1.57	8.40**	5.94**
J-23	82.20	80.39	74.16	78.92	0.65	0.89	-1.72	-0.06	0.60	1.57	-1.25*	0.31
RLC-6	56.57	71.15	79.65	69.12	-8.14**	-4.41**	0.88	-3.89**	-11.21**	-3.68**	0.68	-4.73**
Garima	74.17	75.08	65.43	71.56	-2.94**	-3.58**	-7.47**	-4.66**	-0.74	-1.38	-6.54**	-2.89**
KL-43	81.63	94.78	81.20	85.87	0.63	5.00**	4.72**	3.45**	2.44*	4.88**	3.55**	3.62**
LCK-88062	89.33	77.47	82.59	83.13	3.24**	-0.06	6.46**	3.21**	6. 1 1**	0.42	3.92**	3.15**
SE (m) ±	**4.40**	**6.25**	**5.92**	**3.22**								
SE (gi) ±					**0.85**	**1.21**	**1.15**	**0.62**	**1.01**	**0.84**	**0.59**	**0.48**
SE (gi-gj) ±					**1.27**	**1.80**	**1.71**	**0.93**	**1.50**	**1.26**	**0.88**	**0.74**

Table Contd….

Technical plant height (cm.)

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	56.33	54.68	55.87	55.62	0.23	1.37**	-3.71**	-0.71*	1.60**	0.39	2.25**	1.41**
Shubhra	52.74	42.30	40.13	45.07	-3.59**	-4.73**	-8.05**	-5.46**	-0.88	-4.29**	-4.36**	-3.18**
Sweta	40.23	46.38	42.53	43.05	-5.41**	-6.52**	-5.42**	-5.78**	-7.19**	-5.00**	-3.80**	-5.33**
LMH-62	41.62	54.70	40.19	45.50	-6.23**	1.82**	-5.85**	-3.42**	-4.91**	0.44	-3.62**	-2.69**
DPL-21	74.22	53.42	73.36	67.00	16.11*	4.50**	14.90**	11.84**	8.88**	2.12**	9.04**	6.68**
J-23	35.52	50.06	42.53	42.70	-3.95**	-2.74**	-4.00**	-3.57**	-1.31*	-0.93	-2.83**	-1.69**
RLC-6	39.52	46.27	40.96	42.25	-5.97**	-4.27**	-4.80**	-5.01**	-5.21**	-2.85**	-4.88**	-4.32**
Garima	51.03	51.93	46.49	49.82	-1.30*	-0.81*	-0.46	-0.86**	0.31	0.57	-2.32**	-0.48
KL-43	53.52	62.06	53.50	56.36	-0.39	7.22**	5.90**	4.24**	2.82**	7.01**	4.10**	4.64**
LCK-88062	66.90	56.50	61.59	61.66	10.52**	4.16**	11.49**	8.72*	5.90**	2.54**	6.41**	4.95**
SE (m) ±	**3.15**	**2.10**	**2.85**	**1. 58**								
SE (gi) ±					**0.61**	**0.41**	**0.55**	**0.31**	**0.62**	**0.63**	**0.85**	**0.41**
SE (gi-gj) ±					**0.91**	**0.61**	**0.82**	**0.46**	**0.92**	**0.94**	**1.26**	**0.61**

Table Contd….

Number of tillers/plant

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	5.00	4.11	4.22	4.44	-0.15**	-0.47**	-0.14**	-0.25**	0.03	0.32	-0.24	0.04
Shubhra	5.73	5.08	5.63	5.48	-0.56**	-0.02	0.43**	-0.05	-0.33**	0.92	0.64**	0.41*
Sweta	6.01	5.69	3.50	5.07	-0.01	-0.20*	-0.56**	-0.26**	-0.002	-0.31	-0.56**	-0.30
LMH-62	5.04	3.69	4.18	4.30	-0.78**	-0.61**	-0.37**	-0.59**	-0.30**	-0.78	-0.32*	-.47**
DPL-21	8.32	7.12	6.18	7.21	1.46**	0.85**	1.22**	1.18**	1.03**	0.50	0.53**	0.69**
J-23	4.20	3.65	5.00	4.28	-1.03**	-0.50**	-0.16**	-0.56**	-1.11**	-0.62	0.08	-0.55**
RLC-6	4.67	4.17	4.16	4.33	-0.53**	-0.53**	-0.50**	-0.52**	-0.80**	-0.72	-0.48**	-0.67**
Garima	5.88	5.35	4.62	5.28	-0.03	0.25**	-0.32**	-0.03	-0.11	0.03	0.02	-0.02
KL-43	6.88	6.00	5.17	6.02	0.28**	0.27**	0.45**	0.33**	0.46**	0.10	0.36**	0.31
LCK-88062	8.33	7.11	4.34	6.60	1.36**	0.96**	-0.03	0.76**	1.14**	0.56	-0.02	0.56**
SE (m) ±	**0.30**	**0.46**	**0.27**	**0.20**								
SE (gi) ±					**0.06**	**0.09**	**0.05**	**0.04**	**0.06**	**0.49**	**0.13**	**0.17**
SE (gi-gj) ±					**0.08**	**0.13**	**0.08**	**0.06**	**0.09**	**0.73**	**0.19**	**.25**

Table Contd….

Number of branches/plant

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	31.00	21.66	21.16	24.61	-2.73**	-2.06**	-0.16	-1.65**	-2.42**	-1.46*	0.94	-0.98**
Shubhra	31.00	26.15	17.57	24.91	2.49**	2.56**	-0.80	1.42**	2.27**	2.41**	-1.42*	1.09**
Sweta	31.67	28.33	15.26	25.08	3.07**	2.97**	-1.41*	1.54**	2.16**	2.83**	-1.92**	1.03**
LMH-62	33.67	26.75	26.93	29.11	2.88**	3.74**	5.09**	3.90**	3.16**	2.92**	2.89**	2.99**
DPL-21	27.33	25.19	19.47	24.00	-1.51**	2.54**	0.20	0.41	-0.76	1.31*	0.62	0.39
J-23	32.00	20.65	21.74	24.80	2.88**	-0.77	0.83	0.98**	1.74**	0.02	1.68*	1.15**
RLC-6	29.33	22.32	22.32	24.66	1.85**	1.65**	1.04	1.51**	0.44	1.03	0.51	0.66
Garima	29.00	21.38	20.34	23.57	-1.18**	1.18**	0.57	0.19	-1.34**	-0.75	0.61	-0.49
KL-43	26.67	19.26	18.39	21.44	-2.84**	-5.00**	-1.59*	-3.15**	-2.17**	3-04**	0.19	-1.68**
LCK-88062	24.67	17.03	11.73	17.81	-4.90**	-6.80**	-3.76**	-5.16**	-3.09**	-5.29**	-4.10**	-4.16**
SE (m) ±	**2.07**	**2.86**	**3.64**	**1.69**								
SE (gi) ±					**0.40**	**0.55**	**0.70**	**0.33**	**0.44**	**0.62**	**0.70**	**0.34**
SE (gi-gj) ±					**0.60**	**0.82**	**1.05**	**0.49**	**0.65**	**0.93**	**0.04**	**0.51**

Table Contd….

Number of capsules/plant

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	93.89	43.54	50.56	62.67	9.18**	-8.98**	1.99**	0.73	4.57**	-9.65**	2.10**	-0.99**
Shubhra	84.57	37.19	42.33	54.70	4.54**	-8.31**	0.51	-1.09*	5.61**	-8.18**	-1.81**	-1.46**
Sweta	70.82	53.62	49.44	57.96	-3.66**	1.26	2.47**	0.02	-2.61**	-1.58**	1.48*	-0.90*
LMH-62	75.28	73.23	53.65	67.39	0.40	12.17**	4.34**	5.64**	0.50	11.07**	3.00**	4.86**
DPL-21	76.67	51.20	54.38	60.75	-0.37	-2.94**	2.86**	-0.15	1.56*	-1.80**	3.41**	1.06**
J-23	81.93	43.25	53.06	59.42	4.23**	-3.33**	0.07	0.33	3.61**	-3.28**	1.28	0.56
RLC-6	60.00	66.52	42.04	56.19	-9.30**	7.27**	-3.47**	-1.83**	-7.64**	8.91**	-3.67**	-0.80*
Garima	77.59	51.57	40.10	56.42	-0.51	-1.01	-3.66**	-1.72**	-3.10**	0.12	-2.01**	-1.67**
KL-43	84.11	60.16	46.20	63.49	0.80	4.44**	-4.11**	0.38	2.78**	3.51**	-2.00**	1.43**
LCK-88062	67.53	55.52	45.00	56.02	-5.32**	-0.58	-1.00	-2.30**	-5.34**	0.88	-1.78*	-2.08**
SE (m) ±	**5.65**	**3.66**	**3.75**	**2.57**								
SE (gi) ±					**1.09**	**0.71**	**0.73**	**0.50**	**0.71**	**0.53**	**0.70**	**0.38**
SE (gi-gj) ±					**1.63**	**1.06**	**1.08**	**0.74**	**1.06**	**0.80**	**1.05**	**0.56**

Table Contd....

Number of seeds/capsule

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	8.07	7.78	8.23	8.03	-0.05	0.93**	0.23	0.37**	0.06	0.45**	0.23**	0.25**
Shubhra	8.07	5.71	8.35	7.38	0.10*	-0.25**	0.13	-0.01	0.09*	-0.18**	0.25**	0.05**
Sweta	7.37	6.18	7.21	6.92	-0.39**	0.16**	-0.22	-0.15**	-0.44**	0.12**	-0.08**	-0.14**
LMH-62	7.78	6.22	7.56	7.19	-0.04	0.26**	-0.16	0.02	-0.09*	0.11**	-0.09**	-0.02
DPL-21	7.33	5.97	7.12	6.81	-0.40**	-0.35**	-0.01	-0.25**	-0.24**	-0.12**	-0.25**	-0.20**
J-23	8.25	6.25	8.16	7.55	0.00	0.01	0.27	0.09	0.23*	0.17**	0.24**	0.21**
RLC-6	8.62	5.69	6.60	6.97	0.30**	-0.21**	-0.71**	-0.21**	0.39**	-0.20**	-0.69**	-0.17**
Garima	8.21	5.91	7.56	7.23	0.13**	-0.17**	0.06	0.01	0.05	-0.15**	0.00	-0.03
KL-43	7.65	5.87	7.79	7.10	-0.17**	-0.34**	0.16	-0.11	-0.27**	-0.18**	0.24**	-0.07**
LCK-88062	9.09	6.05	7.80	7.65	0.52**	-0.03	0.24	0.24**	0.23**	-0.02	0.15**	0.12**
SE (m) ±	**0.28**	**0.17**	**0.83**	**0.30**								
SE (gi) ±					**0.05**	**0.03**	**0.16**	**0.06**	**0.04**	**0.03**	**0.03**	**0.03**
SE (gi-gj) ±					**0.08**	**0.05**	**0.24**	**0.08**	**0.06**	**0.04**	**0.04**	**0.03**

Table Contd....

1000—seed weight (g.)

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	10.00	7.03	8.80	8.61	1.03**	0.15**	-0.25	0.31**	0.57**	0.29**	0.25**	0.37**
Shubhra	7.82	6.81	7.12	7.25	-0.34**	-0.01	-1.34**	-0.56*	-0.03	-0.01	-0.37**	-0.13**
Sweta	9.50	7.11	8.19	8.29	0.56**	0.32**	-0.65	0.08	0.44**	0.32**	0.18**	0.31**
LMH-62	8.50	6.29	7.29	7.36	0.11**	-0.03	-0.88**	-0.27	0.22**	0.001	0.03	0.08**
DPL-21	8.10	6.03	7.07	7.07	-0.09**	-0.15**	-1.14	-0.46	0.09**	-0.21**	-0.59**	-0.24**
J-23	8.10	6.10	7.76	7.32	-0.07**	-0.20**	2.61**	0.78**	0.10*	-0.06	0.11**	-0.05**
RLC-6	6.38	5.92	8.24	6.85	-0.48**	-0.23**	-0.70	-0.47**	-1.06**	-0.35**	0.000	-0.47**
Garima	8.41	6.06	9.07	7.85	-0.02	-0.07	0.20	0.04	0.20**	-0.21**	0.76**	0.25**
KL-43	7.60	6.08	7.04	6.91	-0.34**	-0.28**	3.07**	0.81**	-0.17**	-0.15**	-0.21**	-0.18**
LCK-88062	7.19	6.95	7.90	7.35	-0.36**	0.49**	-0.92**	-0.26	-0.36**	0.39**	0.05	0.03
SE (m) ±	**0.17**	**0.27**	**4.32**	**1.44**								
SE (gi) ±					**0.03**	**0.05**	**0.26**	**0.11**	**0.03**	**0.05**	**0.03**	**0.02**
SE (gi-gj) ±					**0.05**	**0.08**	**0.32**	**0.15**	**0.04**	**0.08**	**0.04**	**0.03**

Table Contd….

Harvest index (%)

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	32.24	29.56	30.82	30.87	1.45**	0.71	-0.21	0.65**	0.70*	1.22**	0.32	0.75**
Shubhra	33.27	24.53	35.95	31.25	0.81*	-1.20**	3.23**	0.94**	0.90**	-0.98*	2.75**	0.89**
Sweta	26.35	27.80	27.47	27.21	-1.71**	0.50	-1.87**	-1.03**	-1.60**	0.70	-1.36*	-0.75**
LMH-62	37.93	29.84	35.61	34.46	4.56**	3.00**	2.56**	3.37**	3.46**	2.12**	2.51**	2.70**
DPL-21	27.31	23.63	27.39	26.11	-1.14**	-2.08**	-2.24**	-1.82**	-1.91**	-1.76**	-3.66**	-2.44**
J-23	29.84	21.25	34.56	28.55	-0.66	-2.20**	0.88*	-0.66**	0.04	-3.29**	0.78*	-0.82*
RLC-6	26.94	22.04	28.09	25.69	-1.09**	-2.29**	-1.86**	-1.75**	-0.74**	-2.02**	-0.77	-1.18**
Garima	31.18	33.23	35.29	33.23	-0.75**	3.57**	2.17**	1.66**	0.43	2.61**	1.32*	1.45**
KL-43	24.53	27.51	27.20	26.41	-1.97**	-1.05**	-2.27**	-1.76**	-1.92**	-0.51	-2.41**	-1.62**
LCK-88062	32.26	29.88	30.91	31.02	0.51	1.04**	-0.38	0.39	0.65*	1.90**	0.52	1.03**
SE (m) ±	**1.83**	**2.07**	**1.92**	**1.12**								
SE (gi) ±					**0.35**	**0.40**	**0.37**	**0.22**	**0.31**	**0.43**	**0.66**	**0.28**
SE (gi-gj) ±					**0.53**	**0.60**	**0.55**	**0.32**	**0.47**	**0.64**	**0.98**	**0.42**

Table Contd….

Fibre yield/plant (g.)

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	2.70	2.30	2.41	2.47	0.20**	0.30**	0.12**	0.21**	0.36**	0.001	0.30**	0.22**
Shubhra	1.76	0.95	1.06	1.26	-0.14**	-0.51**	-0.46**	-0.37**	-0.07**	-0.42**	-0.36**	-0.28**
Sweta	0.78	0.91	1.02	0.90	-0.51**	-0.55**	-0.62**	-0.56**	-0.56**	-0.46**	-0.37**	-0.46**
LMH-62	0.89	1.12	1.04	1.02	-0.69**	-0.21**	-0.69**	-0.53**	-0.57**	-0.09**	0.27**	-0.31**
DPL-21	3.88	2.90	3.91	3.56	1.29**	0.80**	1.42**	1.17**	0.96**	0.66**	0.68**	0.77**
J-23	1.98	1.59	1.43	1.67	-0.04*	-0.23**	-0.31**	-0.19**	0.001	-0.11**	-0.16**	-0.07**
RLC-6	0.90	1.29	1.13	1.11	-0.62**	-0.40**	-0.51**	-0.51**	-0.52**	0.48**	-0.32**	-0.44**
Garima	1.25	1.32	0.98	1.18	-0.47**	-0.34**	-0.61**	-0.48**	-0.32**	-0.26**	-0.44**	-0.33**
KL-43	2.54	3.08	2.67	2.76	0.19**	0.61**	0.63**	0.48**	0.35**	0.56**	0.34**	0.41**
LCK-88062	3.19	2.79	3.29	3.09	0.80**	0.53**	1.03**	0.79**	0.39**	0.55**	0.60**	0.51**
SE (m) ±	**0.11**	**0.17**	**0.14**	**0.08**								
SE (gi) ±					**0.02**	**0.03**	**0.03**	**0.02**	**0.02**	**0.03**	**0.02**	**0.01**
SE (gi-gj) ±					**0.03**	**0.05**	**0.04**	**0.02**	**0.03**	**0.04**	**0.03**	**0.02**

Table Contd….

Oil content (%)

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	41.41	40.16	41.25	40.94	-0.60**	-0.48**	-0.44**	-0.51**	-0.77**	-0.63**	-0.43**	-0.61**
Shubhra	43.96	42.34	42.92	43.07	0.35**	0.19**	-0.08	0.15**	0.38**	0.19**	0.27**	0.28**
Sweta	43.20	43.30	42.83	43.11	-0.02	0.50**	0.42**	0.30**	0.33**	0.53**	0.35**	0.41**
LMH-62	44.86	42.44	44.05	43.78	0.98**	0.37**	0.87**	0.74**	0.72**	0.25**	0.69**	0.55**
DPL-21	43.19	41.47	41.36	42.01	0.13	-0.31**	-0.29**	-0.16**	0.52**	-0.23**	-0.76**	-0.16**
J-23	40.23	41.34	40.60	40.76	-0.89**	-0.26**	-0.53**	-0.56**	-0.81**	-0.34**	-1.09**	-0.75**
RLC-6	43.16	42.95	43.38	43.16	0.26**	0.64**	0.43**	0.44**	0.26*	0.72**	0.61**	0.53**
Garima	41.61	41.64	42.56	41.94	-0.28**	-0.08	-0.29**	-0.22**	-0.53**	0.03	0.18**	-0.11*
KL-43	43.24	42.37	42.90	42.84	0.27**	0.15**	0.06	0.16**	0.06	0.19**	0.25**	0.17**
LCK-88062	42.27	40.81	42.44	41.84	-0.21**	-0.70**	-0.15**	-0.35**	-0.17	-0.71**	-0.06	-0.31**
SE (m) ±	**0.38**	**0.33**	**0.30**	**0.20**								
SE (gi) ±					**0.07**	**0.06**	**0.06**	**0.04**	**0.13**	**0.07**	**0.05**	**0.05**
SE (gi-gj) ±					**0.11**	**0.10**	**0.09**	**0.06**	**0.19**	**0.10**	**0.08**	**0.08**

Table Contd....

Seed yield/plant (g.)

Parents	Mean Value				gca effect F_1				gca effect F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum	5.78	4.72	5.05	5.18	-0.05	-0.14*	-0.60**	-0.26**	0.001	-0.18**	-0.12**	-0.10**
Shubhra	4.12	3.60	6.34	4.69	-0.74**	-0.64**	0.32**	-0. 36**	-0.76**	-0.72**	0.29**	-0.40**
Sweta	2.44	5.55	4.88	4.29	-1.10**	0.19**	-0.44**	-0.45**	-1.61**	0.34**	-0.33**	-0.54**
LMH-62	8.31	7.41	7.95	7.89	1.97**	1.69**	1.60**	1.75**	1.49**	0.92*	0.75**	1.05**
DPL-21	3.07	4.46	4.17	3.90	-1.02**	-0.44**	-0.34**	-0.60**	-1.16**	-0.14**	-0.74**	-0.67**
J-23	5.82	3.50	5.60	4.97	0.19**	-0.48**	-0.04	-0.11**	0.37**	-0.46**	0.22**	0.04*
RLC-6	4.92	4.29	4.47	4.56	-0.06	-0.15**	-0.37**	-0.19**	0.32**	-0.13**	-0.37**	-0.06**
Garima	7.44	5.83	6.86	6.71	0.71**	0.47**	0.51**	0.56**	0.89**	0.60**	0.53**	0.67**
KL-43	4.72	4.66	5.02	4.80	-0.46**	-0.63**	-0.80**	-0.63**	-0.15**	-0.43**	-0.51**	-0.36**
LCK-88062	7.07	5.53	6.26	6.29	0.56**	0.14*	0.16**	0.29**	0.61**	0.18**	0.30**	0.36**
SE (m) ±	0.36	0.32	0.21	0.18								
SE (gi) ±					0.07	0.06	0.04	0.03	0.04	0.05	0.03	0.02
SE (gi-gj) ±					0.10	0.09	0.06	0.05	0.06	0. 07	0.05	0.03

***Significant at $p = 0.05$ ** Significant at $p = 0.01$ L_1 : Rath; L_2: Jabalpur; L_3 Kanpur**

Table 9 (a) : Estimates of SCA effects and corresponding mean performance of 45 F_1s for 13 characters over locations and pooled over locations in 10 x 10 diallel crosses in linseed.

Cross Combination	1. Days to 50% flowering								2. Days to maturity							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	67.33	65.33	74.00	68.89	3.27**	0.27	-0.13	1.14**	130.67	124.00	133.33	129.33	-0.93	-1.13	-3.94**	-2.00**
Neelum x Sweta	60.00	63.67	65.33	62.89	-0.89	-0.40	-1.24	-0.84*	132.00	125.67	130.33	129.33	-1.23*	0.29	-4.08**	-1.68**
Neelum x LMH-62	61.00	62.33	63.00	62.11	1.61*	-0.70	1.09	0.66	126.37	123.33	135.33	128.33	-1.43*	0.93	1.98*	0.49
Neelum x DPL-21	73.00	65.33	74.67	71.00	-3.92**	-6.12**	-0.88	-3.64**	139.00	125.67	143.33	136.00	1.99**	-2.30**	2.81**	0.83
Neelum x J-23	53.67	71.33	71.00	65.33	-5.42**	3.80**	-1.58	-1.07*	134.00	126.33	141.00	133.78	4.54**	1.26	2.64**	2.82**
Neelum x RLC-6	66.33	70.33	73.67	70.11	1.63*	3.80**	1.34	2.26**	131.67	123.67	131.00	128.78	-0.15	0.40	-1.36	-0.37
Neelum x Garima	59.67	65.33	69.67	64.89	-0.70	-0.70	-.013	-0.51	133.67	124.33	134.00	130.67	1.85**	-1.63	-2.13*	-0.64
Neelum x KL-43	69.67	68.00	71.00	69.56	1.19	1.80**	-.085	0.71	133.67	128.67	151.00	137.78	-0.37	-0.16	9.67**	3.05**
Neelum xLCK88062	65.00	63.33	74.00	67.44	1.80*	-1.45*	0.31	0.22	135.33	126.67	137.00	133.00	0.27	0.20	-0.61	-0.05
Shubhra x Sweta	60.67	59.33	67.33	62.44	-0.01	-0.98	-0.08	-0.35	132.67	127.33	130.00	130.11	0.77	2.09*	-0.86	0.67
Shubhra x LMH-62	58.33	57.67	59.67	58.56	-0.84	-1.62**	-3.41**	-1.96**	123.67	123.33	129.67	125.56	-2.76**	1.07	-0.47	-0.72
Shubhra x DPL-21	74.00	72.00	77.33	74.44	-2.70**	4.30**	0.62	0.74	135.33	129.00	136.00	133.44	-0.35	1.18	-1.30	-0.16
Shubhra x J-23	56.33	61.67	74.67	64.22	-2.53**	-2.12**	0.92	-1.24**	128.33	125.00	132.33	128.56	0.21	0.07	-2.80**	-0.84
Shubhra x RLC-6	63.33	65.00	71.67	66.67	-1.14	2.21**	-1.83*	-0.25	131.67	123.00	127.67	127.44	1.18	-0.13	-1.47	-0.14
Shubhra x Garima	64.00	62.33	71.33	65.89	3.86**	0.05	0.37	1.42**	131.33	125.00	132.33	129.56	0.85	-0.82	-0.58	-0.18
Shubhra x KL-43	69.67	61.67	72.33	67.89	1.41	-0.79	-0.69	-0.02	134.00	129.67	147.00	136.89	1.29	0.98	8.89**	3.72**
ShubhraxLCK88062	61.33	60.33	75.67	65.78	-1.64*	-0.70	0.81	-0.51	134.67	128.33	141.00	134.67	0.93	2.01*	6.62**	3.19**
Sweta x LMH - 62	54.33	58.00	56.00	56.11	-1.67*	-0.29	0.81	-0.38	129.33	122.33	129.67	127.11	1.27	-0.18	2.39**	1.16*
Sweta x DPL - 21	86.33	72.33	67.00	75.22	12.80**	5.63**	-1.83*	5.54**	137.33	126.33	132.33	132.00	0.02	-1.74*	-2.11*	-1.28**
Sweta x J 23	55.33	63.33	65.00	61.22	-0.37	0.55	-0.85	-0.22	127.67	125.33	137.33	130.11	-2.10**	0.15	5.06**	1.04*
Sweta x RLC - 6	63.67	61.33	65.00	63.33	2.36**	-0.45	-0.60	0.43	131.67	123.33	129.00	128.00	-0.46	-0.05	2.73**	0.74
Sweta x Garima	55.67	64.00	62.00	60.56	-1.31	2.71**	-1.08	0.11	132.67	126.33	131.00	130.00	0.54	0.26	0.95	0.58
Sweta x KL – 43	55.67	60.33	63.67	59.89	-9.42**	-1.12	-1.46	-4.00**	135.00	130.00	132.00	132.33	0.65	1.07	-3.24**	-0.51
Sweta x LCK 88062	60.67	63.67	67.00	63.78	0.86	3.63**	0.04	1.51**	138.33	126.33	132.67	132.44	2.96**	-0.24	1.14	1.29**
LMH62 x DPL - 21	71.00	71.67	57.67	66.78	-1.03	5.49**	-6.83**	-0.62	128.67	126.33	134.33	129.78	-3.18**	1.23	0.95	-0.33

Table Contd….

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	64.33	65.67	59.33	63.11	10.13**	3.91**	-2.19**	3.95**	126.33	123.33	130.67	126.78	2.04**	1.12	-0.55	0.87
LMH 62 x RLC - 6	53.33	58.67	58.33	56.78	-6.48**	-2.09**	-2.94**	-3.84**	129.33	120.33	127.67	125.78	2.68**	-0.07	2.45**	1.69**
LMH 62 x Garima	57.00	62.67	58.67	59.44	1.52*	2.41**	-0.08	1.29**	126.00	125.67	130.33	127.33	-0.65	2.57**	1.34	1.08*
LMH 62 x KL - 43	65.33	58.67	60.00	61.33	1.74*	-1.76**	-0.80	-0.27	132.00	123.33	130.67	128.67	3.13**	-2.63**	-3.52**	-1.01*
LMH62xLCK 88062	55.00	55.00	62.00	57.33	-3.31**	-4.01**	-0.63	-2.65**	131.33	121.33	127.67	126.78	1.43*	-2.27**	-2.80**	-1.21**
DPL - 21 x J 23	71.33	69.67	73.67	71.56	-0.39	-0.51	-1.49	-0.80	133.00	128.33	136.33	132.56	-0.54	0.57	-2.05*	-0.68
DPL - 21 x RLC - 6	75.00	70.00	77.00	74.00	-2.34**	0.83	2.09**	0.19	135.00	125.67	131.00	130.56	-0.90	-0.30	-1.38	-0.86
DPL - 21 x Garima	76.00	66.00	70.33	70.78	2.99**	-2.67**	-2.05*	-0.58	135.33	131.00	135.33	133.89	-0.57	2.34**	-0.83	0.32
DPL - 21 x KL - 43	85.33	71.00	76.33	77.56	4.22**	2.16**	1.90*	2.76**	141.33	130.33	144.33	138.67	3.21**	-1.18	2.98**	1.67**
DPL-21xLCK 88062	76.00	64.67	73.67	71.44	0.16	-2.76**	-2.60**	-1.73**	141.00	134.00	135.67	136.89	1.85**	4.84**	-1.97*	1.57**
J - 23 x RLC - 6	63.00	64.33	79.67	69.00	3.49**	-0.92	7.73**	3.43**	129.00	124.00	130.67	127.89	0.65	0.93	0.45	0.68
J - 23 x Garima	53.67	65.00	67.00	61.89	-1.51*	0.24	-2.41**	-1.22**	129.00	126.00	135.33	130.11	0.65	0.23	1.34	0.74
J - 23 x KL - 43	61.33	64.67	70.67	65.56	-1.95**	-0.26	-0.80	-1.00*	130.67	128.67	138.67	132.67	0.10	0.04	-0.52	-0.13
J - 23 x LCK 88062	56.33	62.00	73.67	64.00	-1.67*	-1.51*	0.37	-0.94*	131.33	123.67	134.33	129.78	-0.26	-2.60**	-1.13	-1.33**
RLC 6 x Garima	58.67	62.00	70.33	63.67	-2.12**	-1.76**	1.17	-0.90*	131.67	126.33	128.33	128.78	0.96	2.37**	0.34	1.22**
RLC 6 x KL - 43	71.33	62.00	72.00	68.44	2.44**	-1.92**	0.79	0.43	131.33	125.67	129.00	128.67	-1.60*	-1.16	-4.19**	-2.31**
RLC 6 x LCK 88062	64.67	64.67	70.00	66.44	1.05	2.16**	-3.05**	0.05	133.00	125.00	129.00	129.00	-0.96	0.54	-0.47	-0.30
Garima x KL - 43	69.00	64.67	70.67	68.11	4.44**	1.24*	1.98*	2.55**	131.33	129.67	134.33	131.78	-1.60*	0.15	-2.63**	-1.36**
GarimaxLCK 88062	54.33	63.00	70.67	62.67	-4.95**	0.99	0.15	-1.27**	132.67	126.33	135.67	131.56	-1.29	-0.82	2.42**	0.10
KL 43 x LCK 88062	69.33	64.00	73.33	68.89	1.94**	1.83**	0.76	1.51**	135.67	133.00	140.00	136.22	-0.51	2.98**	1.56	1.34**
S.E. (m.diff.) ±	0.11	0.09	0.12	0.06					0.10	0.12	0.12	0.07				
S.E. (S_{ij}) ±					0.74	0.62	0.81	0.42					0.71	0.85	0.84	0.46
S.E. (S_{ij} - S_{ik}) ±					1.09	0.92	1.19	0.62					1.05	1.25	1.23	0.68

Table Contd....

Cross Combination	3. Plant height (Cm.)								4. Tech. Plant height (Cm.)							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	95.07	88.62	85.76	89.81	1.01	2.15	7.19	3.45	58.90	56.97	56.97	57.61	-0.55	-1.39	10.36**	2.81**
Neelum x Sweta	96.90	89.53	76.90	87.78	4.79	-1.61	-5.94	-0.92	64.17	57.53	52.51	58.07	6.53**	0.97	3.27	3.59**
Neelum x LMH-62	92.13	89.51	72.65	84.76	4.79	9.84*	-9.39*	1.75	57.22	61.27	44.23	54.24	0.41	-3.63**	-4.58*	-2.60*
Neelum x DPL-21	96.47	90.23	106.49	97.73	-5.94*	-0.31	6.40	0.05	80.83	65.95	21.59	56.12	1.68	-1.64	-47.87**	-15.98**
Neelum x J-23	93.40	86.90	87.49	89.27	-1.25	-1.97	1.83	-0.47	63.40	62.34	58.57	61.44	4.31*	1.99	7.92**	4.74**
Neelum x RLC-6	95.17	77.88	85.59	86.21	9.31**	-5.70	-2.68	0.31	62.47	55.64	58.32	58.81	5.39**	-3.17*	8.46**	3.56**
Neelum x Garima	94.47	86.64	80.33	87.15	3.40	2.23	0.41	2.02	63.37	62.37	62.14	62.63	1.63	0.10	7.93**	3.22**
Neelum x KL-43	94.37	96.59	104.89	98.61	-0.26	3.60	12.78**	5.37*	56.57	88.32	65.37	70.08	-6.08**	18.01**	4.81**	5.58**
Neelum xLCK88062	96.23	89.93	94.43	93.53	-1.00	2.00	0.58	0.53	74.13	75.56	66.12	71.94	0.57	8.32**	-0.03	2.95**
Shubhra x Sweta	84.37	84.68	63.89	77.64	-1.14	1.34	-6.96	-2.26	56.63	51.19	40.91	49.58	2.82	0.72	-4.00*	-0.16
Shubhra x LMH-62	86.10	72.47	72.40	76.99	5.36	0.61	2.35	2.77	52.57	60.06	45.11	52.58	-0.41	1.26	0.64	0.49
Shubhra x DPL-21	96.50	85.00	71.80	84.43	0.70	2.26	-16.30**	-4.45*	79.21	69.09	55.28	67.86	3.88	7.60**	-9.95**	0.51
Subhra x J-23	95.00	84.95	76.38	85.44	6.95*	3.88	2.70	4.51*	55.68	55.62	44.89	52.06	0.41	1.37	-1.44	0.12
Shubhra x RLC-6	85.03	74.77	81.80	80.54	5.77*	-1.00	5.52	3.43	55.45	55.64	42.95	51.35	2.20	2.92*	-2.58	0.85
Shubhra x Garima	85.00	74.00	69.54	76.18	0.53	-2.60	1.61	-0.16	55.00	60.27	52.12	55.80	-2.92	4.09**	2.25	1.14
Shubhra x KL-43	86.43	85.37	85.96	85.92	-1.60	0.18	5.84	1.47	56.07	61.62	60.54	59.41	-2.76	-2.59	4.32*	-0.34
Shubhra x LCK 88062	86.87	81.65	88.97	85.83	-3.77	1.53	7.11	1.62	72.73	67.09	66.55	68.79	2.99	5.94**	4.72*	4.55**
Sweta x LMH – 62	79.10	75.21	75.23	76.51	0.31	-1.32	0.91	-0.04	43.30	57.40	45.55	48.75	-7.88**	0.39	-1.55	-3.01**
Sweta x DPL – 21	97.00	87.13	99.56	94.56	3.15	-0.28	7.19	3.35	83.57	68.25	82.89	78.24	10.05**	8.55**	15.03**	11.21**
Sweta x J – 23	85.73	87.12	78.38	83.74	-0.37	1.38	0.43	0.48	57.23	55.92	47.81	53.66	3.78	3.46*	-1.14	2.03*
Sweta x RLC – 6	82.87	85.83	83.84	84.18	5.56	5.39	3.29	4.75*	42.17	52.11	46.89	47.05	-9.27**	1.18	-1.27	-3.12**
Sweta x Garima	83.27	85.30	79.44	82.67	0.75	4.03	7.24	4.01	58.17	46.83	52.22	52.41	2.06	-7.56**	-0.28	-1.92
Sweta x KL – 43	89.90	92.77	88.11	90.26	3.82	2.91	3.72	3.48	61.20	56.24	58.24	58.56	4.19*	-6.18**	-0.62	-0.87
Sweta x LCK 88062	93.80	84.64	87.07	88.50	5.11	-0.15	0.94	1.97	79.20	62.43	65.04	68.89	11.27**	3.08*	0.59	4.98**
LMH62 x DPL – 21	97.13	84.92	101.66	94.57	8.05**	8.98*	10.09**	9.04**	83.90	84.17	79.49	82.52	11.21**	16.13**	12.06**	13.14**

Table Contd....

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J - 23	85.80	81.62	80.75	82.72	4.46	7.35	3.60	5.14*	55.87	58.50	45.80	53.39	3.24	-2.30	-2.72	-0.59
LMH 62 x RLC - 6	68.90	68.58	83.39	73.62	-3.64	-0.40	3.64	-0.13	47.30	60.14	44.30	50.59	-3.31	0.93	-3.42	-194
LMH 62 x Garima	77.07	73.22	72.96	74.42	-0.68	3.42	1.56	1.43	60.37	64.86	52.00	59.08	5.09*	2.14	-0.06	2.39*
LMH 62 x KL - 43	85.43	90.53	83.69	86.55	4.12	12.14**	0.10	5.45**	61.57	72.38	60.72	64.89	5.38**	1.63	2.30	3.10**
LMH62xLLK 88062	92.53	72.91	85.16	83.54	8.61**	-0.41	-0.16	2.68	70.83	72.44	74.33	72.53	3.73	4.75**	10.31**	6.27**
DPL – 21 x J - 23	96.63	84.53	103.63	94.93	0.24	-0.62	8.43**	2.68	84.30	63.32	84.87	77.50	9.33**	-0.16	15.60**	8.25**
DPL – 21 x RLC - 6	95.53	78.20	99.32	91.02	7.93**	-1.65	1.53	2.60	77.93	60.61	80.63	73.06	4.98*	-1.33	12.15**	5.27**
DPC – 21 x Garima	96.40	84.47	77.86	86.24	3.59	3.19	-11.59**	-1.40	83.47	72.27	84.55	80.10	5.85**	6.86**	11.73**	8.15**
DPL – 21 x KL - 43	97.37	83.92	106.28	95.86	0.99	-5.34	4.64	0.10	76.72	80.40	93.87	83.66	-1.81	6.96**	14.69**	6.62**
DPL-21xLCK 88062	97.23	84.46	126.84	102.84	-1.75	0.26	23.46**	7.32**	85.90	62.01	91.06	79.66	-3.54	-8.36**	6.29**	-1.87
J – 23 x RLC - 6	84.73	82.68	82.84	83.42	4.88	4.50	-0.54	2.95	56.17	57.57	45.50	53.08	3.28	-2.87*	-4.07*	0.69
J – 23 x Garima	85.37	77.67	75.15	79.39	0.31	-1.34	0.12	-0.50	62.20	57.71	51.11	57.01	4.64*	-0.46	-2.80	0.46
J – 23 x KL – 43	85.83	78.74	82.61	82.39	-2.79	-8.85*	-4.61	-5.42**	63.70	67.73	61.40	64.28	5.23*	1.53	1.13	2.63*
J – 23 x LCK 88062	91.70	84.37	90.23	88.77	0.47	1.85	1.27	1.20	73.93	67.19	69.07	70.06	4.55*	4.05**	3.20	3.94**
RLC 6 x Garima	76.47	72.39	82.48	77.11	0.20	-1.33	4.85	1.24	55.27	58.77	51.37	55.14	-0.28	2.13	-1.75	0.04
RLC 6 x KL - 43	85.27	84.98	90.91	87.05	5.44	2.68	1.09	3.07	66.63	69.75	62.76	66.38	10.18**	5.09**	3.28	6.19**
RLC 6 x LCK 88062	75.97	78.21	87.49	80.56	-6.47*	0.98	-4.06	-3.18	76.90	64.77	69.92	70.53	9.54**	3.17*	4.85**	5.85**
Garima x KL - 43	86.50	70.70	83.93	80.38	1.46	-12.43**	2.46	-2.84	61.20	71.47	63.17	65.28	0.08	3.34*	-0.65	0.93
GarimaxLCK 88062	92.67	81.23	84.24	86.04	5.02	3.17	1.03	3.07	74.23	70.77	74.95	73.32	2.20	5.71**	5.54**	4.58**
KL 43 x LCK 88062	93.97	85.61	94.30	91.29	2.76	-1.03	-1.10	0.21	75.53	73.49	79.83	76.28	2.59	0.40	4.06*	2.35*
S.E. (m.diff.) ±	0.42	0.60	0.56	0.31					0.30	0.20	0.27	0.15				
S.E. (S_{ij}) ±					2.87	4.07	3.85	2.10					2.05	1.37	1.85	1.03
S.E. ($S_{ij} - S_{ik}$) ±					4.22	6.00	5.67	3.09					3.02	2.01	2.73	1.51

Table Contd....

Cross Combination	5. No. of tillers/plant								6. No. of branches/plant							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	6.65	5.08	5.90	5.88	0.53**	0.02	-0.27	0.09	42.00	35.79	25.42	34.40	0.75	-0.21	1.89	0.81
Neelum x Sweta	6.97	4.45	4.95	5.46	0.30	-0.44	-0.22	-0.12	45.67	47.10	22.51	38.43	3.83**	10.70**	-0.41	4.71**
Neelum x LMH-62	7.05	4.14	5.84	5.68	1.14**	-0.33	0.48**	0.43**	41.33	38.72	34.34	38.13	-0.31	1.54	4.93*	2.05
Neelum x DPL-21	8.42	5.52	7.43	7.12	0.27	-0.42	0.48**	0.11	35.67	28.45	24.92	29.68	-1.59	-7.52**	0.40	-2.91*
Neelum x J-23	5.13	4.55	5.87	5.18	-0.53**	-0.04	0.29	-0.09	44.67	37.64	24.79	35.70	3.03*	4.98**	-0.37	2.55
Neelum x RLC-6	4.50	4.40	5.75	4.88	-1.65**	-0.16	0.51**	-0.43**	35.00	50.00	24.72	36.57	-5.61**	14.92**	-0.65	2.89*
Neelum x Garima	5.92	6.41	5.70	6.01	-0.74**	1.07	0.28	0.20	36.67	34.43	25.40	32.17	-0.92	-0.18	0.51	-0.20
Neelum x KL-43	9.93	4.83	7.03	7.27	2.97**	-0.52	0.84**	1.10**	39.00	23.92	18.90	27.27	3.08*	-4.51*	-3.84	-1.76
Neelum xLCK88062	8.84	7.88	6.06	7.60	0.80**	1.84**	0.35*	1.00**	41.67	26.34	24.11	30.71	7.80**	-0.29	3.54	3.69*
Shubhra x Sweta	5.33	5.51	6.90	5.91	-0.93**	0.18	1.15**	0.13	47.33	56.10	27.00	43.48	0.28	15.08**	4.72*	6.69**
Shubhra x LMH-62	7.36	5.09	5.87	6.10	1.86**	0.16	-0.07	0.65**	51.00	47.77	35.47	44.74	4.14**	5.97**	6.68**	5.60**
Shubhra x DPL-21	9.46	6.03	8.25	7.91	1.72**	-0.36	0.73**	0.70**	38.67	44.47	24.31	35.82	-3.81*	3.87*	0.42	0.16
Shubhra x J-23	4.87	4.68	6.52	5.36	-0.37	-0.35	0.37*	-0.12	50.33	39.33	25.54	38.40	3.47*	2.04	1.01	2.17*
Shubhra x RLC-6	5.34	5.40	6.20	5.65	-0.40*	0.39	0.39*	0.13	60.33	44.98	26.16	43.82	14.50**	5.27**	1.42	7.07**
Shubhra x Garima	4.15	6.23	5.95	5.44	-2.10**	0.44	-0.04	-0.57**	46.67	46.61	22.68	38.65	3.86**	7.38**	-1.58	3.22*
Shubhra x KL-43	6.14	6.43	6.14	6.24	-0.41*	0.63*	-0.61**	-0.13	48.67	31.29	19.20	33.05	7.53**	-1.77	-2.90	0.95
Shubhra x LCK 88062	7.71	6.27	6.84	6.94	0.07	-0.23	0.56**	0.14	39.33	22.57	18.91	26.94	0.25	-8.69**	-1.02	-3.15*
Sweta x LMH – 62	4.61	4.86	4.89	4.79	-1.44**	0.12	-0.06	-0.46**	55.00	44.13	33.62	44.25	7.55**	1.92	5.45*	4.97**
Sweta x DPL – 21	7.66	5.73	8.25	7.21	-0.63**	-0.47	1.72**	0.20	47.33	40.51	25.15	37.66	4.28**	-0.50	1.88	1.98
Sweta x J – 23	4.42	4.93	3.72	4.36	-1.38**	0.08	-1.43**	-0.91**	57.67	41.53	26.59	41.93	10.22**	3.84*	2.67	5.58**
Sweta x RLC – 6	6.83	5.06	4.73	5.54	0.54**	0.23	-0.09	0.23	50.00	39.26	26.36	38.54	3.58**	-0.85	2.24	1.66
Sweta x Garima	8.09	6.10	5.44	6.54	1.30**	0.49	0.44*	0.74**	44.67	36.25	23.68	34.87	1.28	-3.39	0.04	-0.69
Sweta x KL – 43	9.22	5.20	6.77	7.06	2.12**	-0.42	1.00**	0.90**	41.67	38.49	21.15	33.77	-0.06	5.02**	-0.33	1.54
Sweta x LCK 88062	9.91	5.47	5.29	6.89	1.72**	-0.84**	0.00	0.29*	40.67	26.07	15.87	27.54	1.00	-5.59**	-3.45	-2.68*
LMH62 x DPL – 21	5.67	5.41	7.17	6.08	-1.85**	-0.39	0.45*	-0.60**	44.67	44.05	31.26	39.99	1.80	2.27	1.49	1.85

Table Contd....

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	4.74	4.55	5.67	4.98	-0.30	0.10	0.32	0.04	53.67	39.90	25.23	39.60	6.41**	1.43	-5.19*	0.89
LMH 62 x RLC - 6	6.67	4.73	4.69	5.36	1.14**	0.32	-0.32	0.38**	49.67	45.19	33.16	42.67	3.44*	4.30*	2.54	3.43*
LMH 62 x Garima	7.41	4.70	5.15	5.75	1.38**	-0.50	-0.04	0.28*	43.67	44.55	33.11	40.44	0.47	4.13*	2.97	2.52*
LMH 62 x KL - 43	4.40	6.40	6.64	5.81	-1.95**	1.18**	0.69**	-0.03	43.33	36.11	29.39	36.28	1.80	1.87	1.41	1.69
LMH62xLCK 88062	7.92	6.53	5.95	6.80	0.50*	0.63*	0.47**	0.53**	41.33	41.47	21.03	34.61	1.86	9.03**	-4.79*	2.03
DPL – 21 x J - 23	8.74	5.60	7.76	7.37	1.46**	-0.31	0.82**	0.66**	41.67	43.11	25.38	36.72	-1.20	5.85**	-0.14	1.50
DPL – 21 x RLC - 6	7.98	5.70	6.53	6.74	0.21	-0.18	-0.07	-0.01	61.67	47.10	26.32	45.03	19.83**	7.42**	0.59	9.28**
DPL – 21 x Garima	9.90	8.22	6.95	8.36	1.63**	1.56**	0.17	1.12**	42.00	50.31	26.69	39.67	3.19*	11.10**	1.44	5.24**
DPL – 21 x KL - 43	8.17	7.05	7.87	7.70	-0.41*	0.37	0.32	0.09	36.33	37.52	24.65	32.83	-0.81	4.48*	1.56	1.74
DPL-21xLCK 88062	10.14	7.83	6.73	8.24	0.48*	0.47	-0.34	0.20	35.67	35.04	24.12	31.61	0.58	3.81*	3.20	2.53*
J - 23 x RLC - 6	7.67	5.11	5.29	6.02	2.40**	0.58	0.07	1.02**	41.33	32.78	26.20	33.44	-4.89**	-3.59	-0.16	-2.88*
J - 23 x Garima	5.85	5.80	5.31	5.65	0.07	0.49	-0.09	0.16	46.33	40.65	29.14	38.71	3.14*	4.75*	3.25	3.71*
J - 23 x KL - 43	5.03	4.76	6.22	5.34	-1.06**	-0.57	0.05	-0.53**	47.00	34.39	25.20	36.20	7.47**	4.67*	1.47	4.54**
J - 23 x LCK 88062	8.03	7.83	6.39	7.42	0.86**	1.82**	0.70**	1.13**	42.33	30.56	27.85	33.58	2.86*	2.64	6.29**	3.93*
RLC 6 x Garima	7.34	5.16	5.30	5.93	1.06**	-0.12	0.24	0.39**	50.67	42.02	24.38	39.02	8.50**	3.70*	-1.72	3.49*
RLC 6 x KL - 43	6.02	5.10	6.22	5.78	-0.56**	-0.20	0.39*	-0.12	35.33	31.43	26.19	30.98	-5.17**	-0.72	2.25	-1.21
RLC 6 x LCK 88062	7.13	5.78	5.70	6.20	-0.53**	-0.20	0.34	-0.13	36.00	32.81	23.74	30.85	-2.45	2.47	1.98	0.67
Garima x KL - 43	7.60	6.33	5.98	6.64	0.51*	0.25	-0.03	0.24	39.00	32.95	27.03	32.99	1.53	1.28	3.57	2.12
GarimaxLCK 88062	6.87	4.50	5.87	5.75	-1.30**	-2.26**	0.33	-1.08**	34.67	34.04	23.38	30.70	-0.75	4.17*	2.09	1.83
KL-43 x LCK 88062	8.30	6.27	6.85	7.14	-0.17	-0.52	0.55**	-0.05	36.67	25.86	21.77	28.10	2.91*	2.16	2.63	2.57*
S.E. (m.diff.) ±	0.03	0.04	0.03	0.02					0.20	0.27	0.35	0.16				
S.E. (S_{ij}) ±					0.20	0.30	0.18	0.13					1.35	1.86	2.37	1.10
S.E. ($S_{ij} - S_{ik}$) ±					0.29	0.44	0.26	0.20					1.98	2.73	3.48	1.62

Table Contd.

Cross Combination	7. No. of capsules/plant								8. No. seeds/capsule							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	95.32	47.97	64.52	69.27	-5.36	-4.65	3.96	-2.02	8.27	7.28	8.75	8.10	-0.86**	-0.08	0.02	-0.31
Neelum x Sweta	95.36	64.07	62.85	74.09	2.87	1.88	0.34	1.70	8.57	7.91	8.84	8.44	-0.06	0.14	0.47	0.18
Neelum x LMH-62	94.70	80.31	70.77	81.93	-1.85	7.20**	6.38**	3.91*	8.74	7.81	8.54	8.36	-0.25	-0.06	0.10	-0.07
Neelum x DPL-21	104.01	57.81	74.26	78.69	8.23*	-0.19	11.35**	6.46**	8.33	7.30	9.07	8.23	-0.30	0.04	0.48	0.07
Neelum x J-23	100.08	56.45	52.15	69.56	-0.30	-1.16	-7.97**	-3.14	9.59	8.00	9.70	9.10	0.56**	0.38**	0.84	0.59**
Neelum x RLC-6	99.67	57.08	62.72	73.16	12.82**	-11.13**	6.14*	9.61	10.05	7.82	7.13	8.33	0.72**	0.43**	-0.75	0.13
Neelum x Garima	94.65	68.06	52.92	71.88	-0.99	8.13**	-3.47	1.23	9.48	7.63	8.49	8.53	0.32	0.19	-0.16	0.12
Neelum x KL-43	100.41	76.34	57.94	78.23	3.47	10.96**	2.00	5.48**	10.10	7.67	8.91	8.89	1.23**	0.39**	0.16	0.59**
Neelum xLCK88062	94.82	66.14	63.25	74.73	3.99	5.78*	4.20	4.66**	10.03	7.67	8.85	8.85	0.48**	0.09	0.02	0.20
Shubhra x Sweta	89.61	72.31	60.91	74.28	1.77	9.45**	-0.13	3.69*	9.38	7.07	7.82	8.09	0.60**	0.48**	-0.45	0.21
Shubhra x LMH-62	93.45	94.48	72.05	86.66	1.54	20.70**	9.14**	10.46**	10.52	7.87	7.51	8.63	1.38**	1.18**	-0.82	0.58**
Shubhra x DPL-21	100.05	66.02	68.22	78.10	8.92*	7.34**	6.79**	7.68**	8.18	6.02	8.58	7.59	-0.60**	-0.06	0.10	-0.19
Shubhra x J-23	108.70	57.33	67.83	77.95	12.96**	-0.95	9.18**	7.06**	8.85	6.28	8.46	7.86	-0.33	-0.16	-0.30	-0.26
Shubhra x RLC-6	86.82	81.91	57.06	75.26	4.62	13.03**	1.96	6.54**	9.93	6.32	8.54	8.27	0.46**	0.11	0.77	0.44*
Shubhra x Garima	90.77	64.12	68.88	74.59	-0.22	3.52	13.96**	5.75**	9.87	5.92	9.11	8.30	0.56**	-0.34**	0.56	0.26
Shubhra x KL-43	88.58	55.16	50.97	64.90	-3.72	-10.89**	-3.50	-6.04**	9.72	6.07	9.30	8.36	0.71**	-0.02	0.65	0.44*
Shubhra x LCK 88062	88.63	55.71	49.71	64.68	2.45	-5.32*	-7.87**	-3.58*	10.22	6.22	8.76	8.40	0.52**	-0.17	0.03	0.13
Sweta x LMH – 62	86.12	88.46	62.57	79.05	2.41	5.11*	-2.29	1.74	8.62	7.02	7.82	7.82	-0.02	-0.08	-0.17	-0.09
Sweta x DPL – 21	74.00	74.89	70.21	73.03	-8.94*	6.65**	6.82**	1.51	8.55	6.26	8.07	7.63	0.27	-0.22*	-0.06	-0.01
Sweta x J – 23	93.23	71.32	54.92	73.16	5.69	3.47	-5.69*	1.16	8.60	7.18	8.12	7.97	-0.08	0.33**	-0.29	-0.01
Sweta x RLC – 6	72.55	67.61	55.07	65.07	-1.46	-10.84**	-1.99	-4.76**	9.40	6.58	8.25	8.08	0.42*	-0.05	0.82	0.40*
Sweta x Garima	94.33	74.81	53.98	74.37	11.54**	4.64	-2.89	4.43**	9.28	7.26	8.65	8.40	0.47**	0.59**	0.45	0.50*
Sweta x KL – 43	86.53	87.94	72.32	82.26	2.43	12.32**	15.90**	10.22**	8.18	6.42	10.06	8.22	-0.34	-0.08	1.76**	0.45*
Sweta x LCK 88062	79.33	75.54	76.57	77.15	1.35	4.94*	17.04*	7.78**	9.80	7.33	7.29	8.14	0.60**	0.53**	-1.09*	0.01
LMH62 x DPL – 21	87.16	63.55	63.55	71.42	0.16	-15.61**	-1.70	-5.72**	8.93	6.36	7.87	7.72	0.29	-0.23*	-0.32	-0.09

Table Contd….

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	103.38	92.10	66.25	87.24	11.78**	13.33**	3.78	9.63**	9.48	7.34	9.90	8.91	0.44*	0.39**	1.43**	0.75**
LMH 62 x RLC - 6	66.78	93.13	59.18	73.03	-11.29**	3.77	0.25	2.42	9.59	7.00	7.73	8.11	0.25	0.27*	0.24	0.26
LMH 62 x Garima	99.86	85.16	67.59	84.20	13.00**	4.07	8.85**	8.64**	9.85	6.98	8.40	8.41	0.68**	0.21	0.14	0.34
LMH 62 x KL - 43	88.16	90.76	58.88	79.27	0.00	4.22	0.59	1.60	8.50	6.57	8.82	7.96	-0.38*	-0.03	0.45	0.01
LMH62xLCK 88062	91.29	80.81	62.58	78.23	9.24*	-0.71	1.18	3.24	9.62	7.19	8.38	8.40	0.06	0.29**	-0.07	0.09
DPL – 21 x J – 23	87.03	70.67	65.62	74.44	-3.80	7.01**	4.63*	2.61	9.42	6.01	9.66	8.36	0.75**	-0.33**	1.04	0.48*
DPL – 21 x RLC - 6	85.81	86.77	48.85	73.81	8.51*	12.52**	-8.59**	4.14*	9.22	6.09	8.49	7.93	0.24	-0.03	0.85	0.36
DPL – 21 x Garima	88.33	68.14	64.70	73.72	2.24	2.16	7.44**	3.95*	9.10	6.43	8.44	7.99	0.29	0.27*	0.03	0.19
DPL – 21 x KL - 43	87.93	73.58	53.38	71.63	0.54	2.15	-3.43	-0.25	9.34	6.22	8.34	7.97	0.83**	0.23*	-0.17	0.30
DPL-21xLCK 88062	84.50	70.07	55.40	69.99	3.23	3.66	-4.52*	0.79	9.32	6.66	9.09	8.36	0.12	0.36**	0.50	0.33
J - 23 x RLC – 6	85.84	81.93	59.71	75.83	3.94	8.07**	5.05*	5.68**	7.25	6.69	7.29	7.74	-0.13	0.21	-0.62	-0.18
J - 23 x Garima	92.18	66.29	55.19	71.22	1.49	0.70	0.71	0.97	9.55	6.67	8.50	8.24	0.35*	0.14	-3.19	0.10
J - 23 x KL – 43	85.93	75.02	51.45	70.80	-6.07	3.99	-2.58	-1.55	8.87	6.17	7.18	7.41	-0.04	-0.19	-1.62**	-0.61**
J - 23 x LCK 88062	87.20	71.60	60.32	73.04	1.32	5.59*	3.18	3.36*	9.74	6.78	10.06	8.86	0.15	0.12	1.19*	0.49**
RLC 6 x Garima	70.13	80.26	52.54	67.74	-7.03	4.08	1.61	-0.45	9.56	6.31	7.88	7.91	0.05	0.01	0.17	0.08
RLC 6 x KL – 43	84.69	90.96	53.18	76.28	6.22	9.33**	2.70	6.08**	9.36	6.12	6.93	7.47	0.15	-0.01	-0.88	-0.25
RLC 6 x LCK 88062	72.76	83.66	64.59	73.67	0.42	7.65**	11.00**	6.16**	9.84	6.60	7.95	8.13	-0.05	0.17	0.07	0.06
Garima x KL - 43	90.82	75.89	46.69	71.14	3.57	2.54	-3.61	0.83	8.76	6.20	9.01	7.99	-0.28	0.03	0.43	0.06
GarimaxLCK 88062	74.25	71.16	52.10	65.84	-6.88	2.83	-1.30	-1.79	9.56	6.24	9.08	8.29	-0.17	-0.24*	0.42	0.01
KL 43 x LCK 88062	84.90	76.45	52.16	71.17	2.46	2.67	-0.79	1.45	9.75	6.27	9.77	8.60	0.32	-0.04	1.01	0.43*
S.E. (m.diff.) ±	0.54	0.35	0.36	0.24					0.03	0.02	0.08	0.03				
S.E. (S_{ij}) ±					3.68	2.38	2.44	1.67					0.18	0.11	0.54	0.19
S.E. ($S_{ij} - S_{ik}$) ±					5.41	3.50	3.59	2.45					0.27	0.16	0.79	0.28

Table Contd.

Cross Combination	9. 1000 Seed weight (g)								10. Harvest Index (%)							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	10.28	7.26	9.25	8.93	0.40**	-0.06	1.34	0.56	38.46	31.11	39.82	36.46	1.41	-0.42	1.86	0.95
Neelum x Sweta	10.23	7.50	9.41	9.05	-0.56**	-0.15	0.81	0.04	36.88	33.28	34.14	34.77	2.34	0.05	1.28	1.22
Neelum x LMH-62	10.08	7.26	8.57	8.63	-0.25*	-0.04	0.19	-0.03	41.51	35.72	36.72	37.98	0.70	-0.01	-0.56	0.04
Neelum x DPL-21	10.41	7.43	9.31	9.05	0.28**	0.26	1.19	0.58	36.95	31.19	32.36	33.50	1.84	0.55	-0.13	0.75
Neelum x J-23	10.47	7.70	8.97	9.05	0.32**	0.57**	-2.90	-0.67	36.18	34.37	36.08	35.54	0.60	3.83**	0.48	1.64*
Neelum x RLC-6	10.76	7.46	9.16	9.13	1.01**	0.37*	0.60	0.66	36.04	31.84	33.35	33.74	0.88	1.40	0.48	0.92
Neelum x Garima	10.02	7.56	10.05	9.21	-0.19	0.31	0.60	0.24	35.88	37.19	38.73	37.26	0.38	0.89	1.83	1.03
Neelum x KL-43	10.30	6.56	10.34	9.06	0.41**	-0.48**	-1.98	-0.68	36.20	31.51	32.77	33.49	1.92	-0.17	0.32	0.69
Neelum xLCK88062	10.95	7.91	8.89	9.25	1.09**	0.10	0.55	0.58	37.62	35.40	36.20	36.41	0.85	1.63	1.86	1.45*
Shubhra x Sweta	9.96	7.34	7.94	8.41	0.56**	-0.15	0.42	0.27	33.94	33.12	40.17	35.75	0.05	1.80	3.87**	1.91**
Shubhra x LMH-62	9.23	7.43	7.96	8.21	0.27*	0.29	0.67	0.41	40.64	37.25	41.10	39.66	0.48	3.42*	0.38	1.43*
Shubhra x DPL-21	8.40	7.33	7.76	7.83	-0.36**	0.30	0.73	0.22	34.95	26.81	37.73	33.16	0.49	-1.93	1.81	0.12
Shubhra x J-23	8.92	6.14	7.76	7.60	0.14	-0.83**	-3.03	-1.24	34.58	30.85	38.73	34.62	-0.37	1.93	-0.31	0.42
Shubhra x RLC-6	8.88	7.27	8.33	8.16	0.51**	0.33*	0.86	0.56	36.18	25.77	37.04	33.00	1.67	-2.77*	0.74	-0.12
Shubhra x Garima	9.23	7.14	9.50	8.62	0.40**	0.04	1.13	0.52	34.63	37.54	39.06	37.08	-0.22	3.15*	-1.27	0.55
Shubhra x KL-43	8.10	6.87	7.62	7.53	-0.41**	-0.02	-3.62	-1.35	34.26	32.84	37.44	34.85	0.62	3.07*	1.55	1.75*
Shubhra x LCK 88062	8.36	8.48	8.17	8.33	-0.13	0.81**	0.92	0.53	38.28	33.81	40.03	37.37	2.16	1.94	2.25	2.12**
Sweta x LMH – 62	9.72	7.64	8.39	8.58	-0.14	0.17	0.41	0.14	38.79	39.95	40.04	39.60	1.15	4.43**	4.42**	3.33**
Sweta x DPL – 21	9.85	7.19	8.36	8.47	0.18	-0.16	0.64	0.22	34.36	29.78	30.62	31.59	2.41*	-0.66	-0.21	0.51
Sweta x J – 23	9.75	8.12	9.35	9.07	0.06	0.82**	-2.13	-0.41	32.55	30.64	33.15	32.11	0.12	0.32	-0.80	-0.12
Sweta x RLC – 6	9.64	7.46	8.95	8.68	0.37**	0.19	0.79	0.45	33.47	32.27	29.54	31.76	1.47	2.04	-1.68	0.61
Sweta x Garima	9.88	7.43	9.40	8.90	0.15	0.00	0.35	0.16	33.70	37.65	36.36	35.90	1.36	1.55	1.12	1.35
Sweta x KL – 43	9.96	7.88	10.34	9.39	0.55**	0.67**	1.59	-0.12	31.68	31.75	28.81	30.75	0.55	0.27	-1.98	-0.39
Sweta x LCK 88062	9.84	8.01	8.29	8.71	0.45**	0.02	0.35	0.27	34.22	34.24	34.13	34.19	0.61	0.67	1.44	0.91
LMH62 x DPL – 21	9.48	7.50	8.24	8.41	0.27*	0.50**	0.74	0.51	41.15	34.89	36.54	37.52	2.93*	1.94	1.28	2.05**

Table Contd...

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	9.49	7.20	7.94	8.21	0.26*	0.25	-3.31	-0.93	39.88	37.84	38.04	38.59	1.19	5.01**	-0.33	1.96**
LMH 62 x RLC - 6	9.77	6.72	8.46	8.32	0.95**	-0.21	0.52	0.42	41.15	36.32	39.29	38.92	2.88*	3.58**	3.65**	3.37**
LMH 62 x Garima	9.31	7.53	10.71	9.18	0.02	0.45**	1.88	0.79	38.97	37.68	38.87	38.51	0.36	-0.92	-0.79	-0.45
LMH 62 x KL - 43	9.03	6.83	10.38	8.75	0.07	-0.03	-1.32	-0.43	38.96	34.28	36.49	36.58	1.57	0.30	1.28	1.05
LMH62xLCK 88062	9.31	7.90	8.85	8.69	0.37**	0.26	1.14	0.59	40.59	34.69	36.67	37.32	0.72	-1.38	-0.49	-0.37
DPL – 21 x J - 23	9.46	6.73	7.90	8.03	0.42**	-0.11	-3.08	-0.92	33.13	25.26	36.10	31.50	0.14	-2.48	2.53*	0.06
DPL – 21 x RLC - 6	8.78	7.09	8.31	8.06	0.15	0.29	0.63	0.36	32.53	31.06	26.83	30.14	-0.04	3.41*	-4.01**	-0.21
DPL – 21 x Garima	9.32	7.24	10.17	8.91	0.23*	0.28	1.60	0.70	32.64	38.91	36.50	36.02	-0.27	5.40**	1.63	2.25**
DPL – 21 x KL - 43	8.88	6.96	8.63	8.15	0.11	0.21	-2.81	-0.83	34.17	30.02	32.50	32.23	2.48*	1.13	2.08	1.89**
DPL-21xLCK 88062	9.32	7.63	8.17	8.37	0.58**	0.11	0.71	0.47	34.62	32.07	33.49	33.37	0.44	1.09	1.17	0.90
J - 23 x RLC - 6	9.00	6.80	8.13	7.98	0.35**	0.04	-3.29	-0.97	34.75	25.76	35.98	32.16	1.70	-1.78	2.03	0.65
J - 23 x Garima	8.85	6.57	9.12	8.18	-0.25*	-0.35*	-3.20	-1.26	33.45	34.50	38.51	35.49	0.06	1.11	0.53	0.57
J - 23 x KL - 43	9.14	7.07	8.12	8.11	0.36**	0.38*	0.37	0.37	34.58	29.93	33.84	32.79	2.41*	1.15	0.30	1.29
J - 23 x LCK 88062	9.02	8.06	8.16	8.41	0.26*	0.58**	-3.04	-0.73	36.06	34.53	35.28	35.29	1.41	3.66**	-0.15	1.64*
RLC 6 x Garima	8.82	7.37	10.54	8.91	0.12	0.48**	1.53	0.71	34.20	34.85	38.36	35.80	1.24	1.55	3.11*	1.97**
RLC 6 x KL - 43	8.91	6.65	9.21	8.26	0.53**	-0.02	-2.67	-0.72	33.46	28.59	32.63	31.56	1.71	-0.10	1.83	1.15
RLC 6 x LCK 88062	8.08	7.58	8.68	8.11	-0.27*	0.13	0.78	0.22	34.08	34.27	32.83	33.73	-0.15	3.49**	0.13	1.16
Garima x KL - 43	9.36	7.18	9.24	8.59	0.52**	0.36*	-3.54	-0.89	32.91	35.04	36.11	34.69	0.83	0.49	1.28	0.87
GarimaxLCK 88062	9.32	8.00	10.08	9.13	0.50**	0.40*	1.30	0.73	35.08	35.30	37.25	35.88	0.51	-1.34	0.53	-0.10
KL 43 x LCK 88062	8.19	7.36	8.47	8.01	-0.30**	-0.02	-3.19	-1.17	33.92	30.69	32.01	32.20	0.57	-1.33	-0.27	-0.34
S.E. (m.diff.) ±	0.02	0.03	0.41	0.14					0.17	0.20	0.18	0.11				
S.E. (S_{ij}) ±					0.11	0.17	2.81	0.94					1.20	1.35	1.25	0.73
S.E. ($S_{ij} - S_{ik}$) ±					0.16	0.26	4.13	1.38					1.76	1.98	1.84	1.07

Table Contd...

Cross Combination	11Fibre yield/plant (g)								12. Oil content (%)							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	2.82	2.65	2.52	2.66	-0.10	0.34**	0.21*	0.15**	44.07	42.89	43.12	43.36	0.56*	0.53*	0.10	0.40**
Neelum x Sweta	2.92	2.57	2.47	2.65	0.36**	0.31**	0.33**	0.33**	43.23	43.57	44.13	43.64	0.09	0.90**	0.60**	0.53**
Neelum x LMH-62	2.75	2.35	1.36	2.15	0.37**	-0.26*	-0.72**	-0.20**	44.91	43.13	45.12	44.39	0.78**	0.59**	1.14**	0.84**
Neelum x DPL-21	4.30	3.65	4.08	4.01	-0.05	0.03	-0.11	-0.04	43.69	42.28	41.57	42.51	0.41	0.42	-1.25**	-0.14
Neelum x J-23	2.85	2.47	2.48	2.60	-0.18**	-0.11	0.02	-0.09	41.84	41.10	42.63	42.12	-0.43	-0.01	0.06	-0.13
Neelum x RLC-6	2.98	2.09	2.48	2.52	0.54**	-0.32**	0.23**	0.15**	43.76	43.23	44.32	43.77	0.35	0.43*	0.79**	0.52**
Neelum x Garima	2.98	2.70	2.37	2.68	0.38**	0.23*	0.21*	0.27**	43.04	42.17	43.53	42.91	0.17	0.09	0.71**	0.32*
Neelum x KL-43	2.85	4.70	3.66	3.74	-0.40**	1.28**	0.26**	0.38**	43.89	41.96	43.46	43.10	0.46	-0.36	0.31	0.13
Neelum xLCK88062	4.08	3.49	4.34	3.97	0.22**	0.14	0.54**	0.30**	42.85	41.92	43.32	42.70	-0.09	0.46*	0.37	0.24
Shubhra x Sweta	3.02	1.45	1.23	1.90	0.80**	0.00	-0.33**	0.16**	44.52	43.92	44.38	44.27	0.43	0.58**	0.49*	0.50**
Shubhra x LMH-62	1.98	1.54	1.20	1.57	-0.05	-0.26*	-0.29**	-0.20**	44.98	42.96	45.38	44.44	-0.11	-0.25	1.04**	0.23
Shubhra x DPL-21	4.49	3.86	4.67	4.34	0.48**	1.05**	1.07**	0.87**	44.28	42.13	43.28	43.23	0.05	-0.40	0.10	-0.08
Shubhra x J-23	2.66	1.78	1.56	2.00	-0.02	0.01	-0.32**	-0.11*	42.56	42.83	43.07	42.82	-0.66**	0.25	0.14	-0.09
Shubhra x RLC-6	2.03	1.85	1.29	1.72	-0.07	0.25*	-0.39**	-0.07	44.37	44.57	43.72	44.22	0.00	1.10**	-0.18	0.31*
Shubhra x Garima	2.17	1.58	1.27	1.67	-0.08	-0.08	-0.30**	-0.15**	44.00	42.76	42.91	43.22	0.18	0.01	-0.27	-0.03
Shubhra x KL-43	3.07	1.63	3.77	2.83	0.17**	-0.98**	0.95**	0.05	44.70	43.36	43.80	43.96	0.32	0.37	0.28	0.33**
Shubhra x LCK 88062	4.02	3.27	3.93	3.74	0.49**	0.74**	0.72**	0.65**	44.13	41.33	42.54	42.67	0.23	-0.81**	-0.77**	-0.45**
Sweta x LMH – 62	1.10	1.79	1.17	1.35	-0.57**	0.04	-0.17	-0.23**	44.95	44.36	44.85	44.72	0.24	0.84**	0.01	0.36**
Sweta x DPL – 21	4.50	3.64	3.95	4.03	0.85**	0.87**	0.50**	0.74**	44.08	42.23	44.91	43.74	0.22	-0.61**	1.23**	0.28*
Sweta x J – 23	3.03	1.77	1.61	2.14	0.72**	0.04	-0.11	0.22**	43.57	42.76	44.47	43.60	0.71**	-0.14	1.04**	0.54**
Sweta x RLC – 6	1.10	1.58	1.33	1.34	-0.64**	0.02	-0.18*	-0.27**	44.45	43.44	43.59	43.83	0.45	-0.35	-0.82**	-0.24
Sweta x Garima	1.65	1.52	1.19	1.45	-0.24**	-0.09	-0.22*	-0.19**	43.38	42.66	43.54	43.19	-0.07	-0.41	-0.14	-0.21
Sweta x KL – 43	2.79	1.77	2.93	2.50	0.24**	-0.80**	0.27**	-0.10*	43.54	44.00	43.67	43.74	-0.47	0.70**	-0.35	-0.04
Sweta x LCK 88062	3.78	3.11	3.74	3.54	0.62**	0.62**	0.68**	0.64**	42.98	41.65	44.89	43.17	-0.55*	-0.80**	1.07**	-0.09
LMH62 x DPL – 21	4.10	3.95	4.21	4.09	0.63**	0.84**	0.83**	0.77**	45.20	43.00	45.08	44.43	0.33	0.29	0.95**	0.53**

Table Contd....

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	2.28	2.12	1.58	1.99	0.15**	0.05	-0.07	0.04	43.54	42.85	44.42	43.60	-0.31	0.09	0.53**	0.10
LMH 62 x RLC - 6	1.17	1.82	1.44	1.48	-0.39**	-0.08	0.00	-0.16**	45.93	43.10	44.27	44.10	-0.07	-0.56*	-0.59**	-0.40**
LMH 62 x Garima	1.60	2.22	1.17	1.66	-0.11	0.26*	-0.17	-0.01	44.88	43.26	43.95	44.03	0.43	0.32	-0.18	0.19
LMH 62 x KL - 43	2.90	3.79	3.00	3.23	0.54**	0.87**	0.41**	0.60**	45.02	42.46	44.11	43.87	0.02	-0.71**	-0.36	-0.35**
LMH62xLCK 88062	3.61	3.33	3.62	3.52	0.63**	0.49**	0.63**	0.59**	44.92	43.61	44.23	44.25	0.39	1.29**	-0.04	0.55**
DPL – 21 x J - 23	4.62	3.33	4.57	4.17	0.51**	0.24*	0.80**	0.52**	43.77	42.44	41.92	42.71	0.77**	0.36	-0.81**	0.11
DPL – 21 x RLC – 6	4.10	2.77	4.15	3.67	0.57**	-0.14	0.59**	0.34**	43.90	43.52	45.24	44.22	-0.24	0.54*	1.55**	0.62**
DPL – 21 x Garima	4.49	3.20	4.22	3.97	0.81**	0.23*	0.76**	0.60**	44.07	42.50	42.91	43.16	0.47	0.25	-0.06	0.22
DPL – 21 x KL - 43	3.95	3.87	4.05	3.96	-0.39**	-0.06	-0.66**	-0.37**	44.00	42.70	44.09	43.58	-0.15	0.22	0.72**	0.26*
DPL-21xLCK 88062	4.65	3.24	4.49	4.13	-0.31**	-0.61**	-0.62**	-0.51**	43.46	41.66	43.89	43.00	-0.22	0.03	0.78**	0.20
J - 23 x RLC - 6	2.56	1.92	1.65	2.04	0.36**	0.04	-0.19*	0.07	44.57	43.26	44.44	43.92	0.94**	0.24	1.00**	0.72**
J - 23 x Garima	2.37	2.04	1.56	1.99	0.01	0.10	-0.17	-0.02	42.98	41.86	43.50	42.78	0.40	-0.45**	0.78**	0.24
J - 23 x KL - 43	3.02	3.30	3.66	3.33	0.01	0.41**	0.68**	0.37**	44.02	43.46	43.54	43.67	0.88**	0.92**	0.47*	0.76**
J - 23 x LCK 88062	3.65	2.97	3.95	3.52	0.03	0.15	0.57**	0.25**	43.66	41.99	43.42	43.02	1.00**	0.30	0.55**	0.62**
RLC 6 x Garima	1.76	1.71	1.27	1.58	-0.02	-0.05	-0.26**	-0.11*	44.33	43.90	43.64	43.96	0.60*	0.70**	-0.05	0.42**
RLC 6 x KL - 43	3.03	3.30	3.46	3.27	0.60**	0.58**	0.69**	0.62**	44.37	43.57	44.58	44.17	0.08	0.13	0.54**	0.25*
RLC 6 x LCK 88062	3.54	3.18	3.68	3.47	0.49**	0.54**	0.51**	0.51**	43.91	42.30	43.65	43.29	0.10	-0.28	-0.18	-0.12
Garima x KL - 43	3.02	3.24	3.24	3.16	0.43**	0.46**	0.57**	0.49**	44.09	42.90	43.35	43.45	0.35	0.18	0.04	0.19
GarimaxLCK 88062	3.38	2.65	3.54	3.19	0.19**	-0.05	0.47**	0.20**	43.92	42.87	43.09	43.29	0.65**	1.00**	-0.02	0.54**
KL 43 x LCK 88062	4.04	3.22	3.65	3.64	0.19**	-0.44**	-0.67**	-0.30**	44.45	41.81	43.32	43.19	0.63*	-0.29	-0.13	0.07
S.E. (m.diff.) ±	0.01	0.02	0.01	0.01					0.04	0.03	0.03	0.02				
S.E. (S_{ij}) ±					0.06	0.11	0.09	0.05					0.25	0.22	0.20	0.13
S.E. ($S_{ij} - S_{ik}$) ±					0.10	0.16	0.14	0.08					0.36	0.32	0.29	0.19

Table Contd...

Cross Combination	13. Seed yield/plant (g)							
	Mean Value				SCA effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	6.66	5.14	6.77	6.19	0.52*	-0.28	0.20	0.15
Neelum x Sweta	6.55	6.28	5.71	6.18	0.78**	0.02	-0.10	0.23*
Neelum x LMH-62	9.27	10.01	7.95	9.08	0.43	0.26	0.10	0.93**
Neelum x DPL-21	6.58	5.71	5.12	5.80	0.73**	0.08	-0.79**	0.01
Neelum x J-23	6.80	6.00	5.84	6.21	-0.26	0.41*	-0.36**	-0.07
Neelum x RLC-6	7.36	5.46	7.53	6.78	0.55*	-0.45*	1.65**	0.58**
Neelum x Garima	7.53	6.52	6.54	6.86	-0.05	-0.01	-0.21	-0.09
Neelum x KL-43	6.00	5.93	5.32	5.75	-0.41	0.50*	-0.13	-0.01
Neelum xLCK88062	7.23	6.08	7.23	6.85	-0.20	-0.12	0.82**	0.17
Shubhra x Sweta	5.06	6.43	7.34	6.28	-0.03	0.68**	0.61**	0.42**
Shubhra x LMH-62	9.43	8.40	8.39	8.74	1.28**	1.16**	-0.38**	0.69**
Shubhra x DPL-21	5.07	5.32	7.13	5.84	-0.10	0.20	0.30*	0.13
Shubhra x J-23	5.98	4.87	8.38	6.41	-0.39	-0.22	1.26**	0.22*
Shubhra x RLC-6	6.49	5.70	8.04	6.75	0.37	0.30	1.24**	0.64**
Shubhra x Garima	7.66	6.60	7.09	7.12	0.76**	0.58**	-0.58**	0.25*
Shubhra x KL-43	5.29	5.62	6.40	5.77	-0.44	0.69**	0.03	0.09
Shubhra x LCK 88062	7.42	5.22	6.91	6.52	0.67**	-0.48*	-0.42**	-0.08
Sweta x LMH – 62	8.90	7.63	9.72	8.75	1.11**	-0.45*	1.71**	0.79**
Sweta x DPL – 21	3.77	6.02	6.49	5.43	-1.04**	0.07	0.42**	-0.18
Sweta x J – 23	6.49	6.93	5.87	6.43	0.48*	1.02**	-0.49**	0.33**
Sweta x RLC – 6	5.95	6.75	4.83	5.84	0.19	0.51*	-1.21**	-0.17
Sweta x Garima	7.55	7.07	7.10	7.24	1.01**	0.21	0.19	0.47**
Sweta x KL – 43	6.23	5.06	5.11	5.47	0.86**	-0.70**	-0.50**	-0.12
Sweta x LCK 88062	7.60	7.23	8.12	7.65	1.22**	0.70**	1.55**	1.15**
LMH62 x DPL – 21	9.13	7.05	10.55	8.91	1.26**	-0.40	2.44**	1.10**

Table Contd....

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	9.40	8.47	7.82	8.56	0.32	1.05**	-0.58**	0.26*
LMH 62 x RLC - 6	9.55	8.24	8.79	8.86	0.72**	0.50*	0.70**	0.64**
LMH 62 x Garima	8.90	8.64	9.25	8.93	-0.70**	0.28	0.30*	-0.04
LMH 62 x KL - 43	8.87	6.76	8.10	7.91	0.43	-0.50*	0.45**	0.13
LMH62xLCK 88062	9.68	8.45	8.07	8.74	0.23	0.42*	-0.54**	0.04
DPL – 21 x J - 23	7.03	5.22	7.62	6.62	0.94**	-0.07	1.15**	0.67**
DPL – 21 x RLC – 6	6.68	6.55	5.18	6.14	0.84**	0.94**	-0.96**	0.27*
DPL – 21 x Garima	7.50	6.30	7.88	7.23	0.89**	0.08	0.86**	0.61**
DPL – 21 x KL - 43	5.00	5.38	6.37	5.58	-0.44	0.25	0.65**	0.15
DPL-21xLCK 88062	7.00	6.47	6.61	6.69	0.54*	0.56**	-0.07	0.34**
J - 23 x RLC - 6	7.29	5.83	7.14	6.75	0.24	0.26	0.70**	0.40**
J - 23 x Garima	8.03	6.25	7.97	7.42	0.21	0.06	0.66**	0.31**
J - 23 x KL - 43	7.53	5.54	5.83	6.30	0.88**	0.45*	-0.18	0.38**
J - 23 x LCK 88062	8.22	6.39	7.14	7.25	0.54*	0.53*	0.17	0.41**
RLC 6 x Garima	7.78	7.27	8.06	7.71	0.21	0.76**	1.08**	0.68**
RLC 6 x KL - 43	7.03	5.36	5.40	5.93	0.63**	-0.06	-0.29*	0.09
RLC 6 x LCK 88062	7.42	6.65	7.03	7.03	0.00	0.46*	0.38**	0.28**
Garima x KL - 43	7.98	6.42	6.67	7.03	0.81**	0.38	0.11	0.43**
GarimaxLCK 88062	6.87	7.09	7.11	7.02	-1.32**	0.28	-0.41**	-0.48**
KL 43 x LCK 88062	7.30	5.28	6.56	6.38	0.27	-0.43*	0.34**	0.06
S.E. (m.diff.) ±	0.03	0.03	0.02	0.02				
S.E. (S_{ij}) ±					0.24	0.21	0.13	0.11
S.E. ($S_{ij} - S_{ik}$) ±					0.35	0.31	0.20	0.17

* Significant at $p = 0.05$ ** Significant at $p = 0.01$ L_1: Rath; L_2; Jabalpur; L_3: Kanpur

Table-9 (b) : Estimates of SCA effects and corresponding mean performance of 45 F_2s for 13 characters over locations and pooled over locations in 10 x 10 diallel crosses in linseed.

Cross Combination	1. Days to 50% flowering								2. Days to maturity							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	67.33	63.67	74.33	68.11	2.10*	-0.18	-0.96	0.32	134.67	127.00	139.33	133.67	-0.76	-2.64	0.12	-1.09
Neelum x Sweta	60.67	65.33	73.33	66.44	-0.59	4.74**	0.68	1.61**	136.00	127.33	141.00	134.78	-0.40	-2.08	2.62**	0.05
Neelum x LMH-62	61.67	61.00	73.00	65.22	2.49**	-1.10*	3.32**	1.57**	135.67	127.33	144.00	135.67	1.91**	5.22	4.48**	3.87**
Neelum x DPL-21	71.67	63.0	80.00	71.56	-4.48**	-4.87**	-0.80	-3.38**	148.33	130.00	148.67	142.33	3.27**	-4.03	0.23	-0.18
Neelum x J-23	55.00	65.33	74.33	64.89	-3.84**	-0.46	-2.77*	-2.36**	132.33	132.00	144.00	136.11	-0.62	1.81	1.48	0.89
Neelum x RLC-6	65.67	66.00	75.00	68.89	1.77*	0.18	1.18	1.04*	133.33	127.67	140.00	133.67	-0.59	-1.81	2.45**	0.02
Neelum x Garima	58.33	63.33	73.00	64.89	-2.40**	-1.40*	0.32	-1.16*	138.00	129.00	143.67	136.89	3.85**	3.67	2.54**	3.35*
Neelum x KL-43	66.67	63.67	73.67	68.00	-1.34	-1.10*	2.04	-0.13	137.33	140.67	143.00	140.22	-0.67	4.03	-3.19**	0.06
Neelum xLCK88062	66.33	65.67	78.67	70.22	3.80**	0.82	0.65	1.76**	143.33	135.67	146.00	141.56	2.74**	3.39	3.76**	3.30*
Shubhra x Sweta	60.67	56.33	73.67	63.56	-1.06	-1.12*	1.54	-0.22	136.67	130.67	132.67	133.33	-0.12	1.72	0.31	0.64
Shubhra x LMH-62	59.00	60.67	62.67	60.78	-0.65	1.71**	-6.49**	-1.81**	134.67	129.00	132.67	132.11	0.52	7.36	-0.83	2.35
Shubhra x DPL-21	70.67	63.00	74.00	69.22	-5.95**	-1.73**	-6.27**	-4.65**	152.33	130.67	144.00	142.33	6.88**	-2.89	1.59*	1.86
Shubhra x J-23	56.00	63.33	81.33	66.89	-3.31**	0.68	4.76**	0.71	134.00	130.67	138.00	134.22	0.66	0.94	1.51*	1.04
Shubhra x RLC-6	66.33	61.33	76.33	68.00	1.96*	-1.35*	3.04**	1.22*	134.33	128.00	133.00	131.78	0.02	-1.00	1.48	0.17
Shubhra x Garima	64.33	62.00	70.33	65.56	3.13**	0.40	-1.82	0.57	133.33	130.00	134.00	132.44	-1.20	5.17	-1.10	0.94
Shubhra x KL-43	74.00	62.33	72.00	69.44	5.52**	0.71	0.90	2.38**	141.00	140.00	141.00	140.67	2.60**	4.17	0.84	2.54
ShubhraxLCK88062	62.67	62.00	78.33	67.67	-0.34	0.29	0.84	0.27	144.67	132.33	134.67	137.22	3.69**	0.86	-1.55*	1.00
Sweta x LMH – 62	57.33	56.33	63.67	59.11	0.66	0.63	-2.85*	-0.52	136.33	127.67	128.00	130.67	1.21	6.25	-4.66**	0.94
Sweta x DPL – 21	85.33	57.33	83.00	75.22	11.69**	-4.15**	5.37**	4.30**	149.33	136.33	142.67	142.78	2.91**	3.00	1.09	2.33
Sweta x J 23	56.33	58.33	76.67	63.78	-0.01	-1.07	2.73*	0.55	133.67	128.33	131.67	131.22	-0.65	-1.17	-3.99**	-1.94
Sweta x RLC – 6	64.33	60.00	69.33	64.56	2.94**	0.57	-1.32	0.73	133.67	128.33	130.67	130.89	-1.62*	-0.44	-0.02	-0.69
Sweta x Garima	59.33	58.67	72.33	63.44	1.10	0.32	2.82*	1.41**	135.67	130.33	135.33	133.78	0.16	5.69	1.06	2.31
Sweta x KL – 43	56.33	57.33	70.67	61.44	-9.17**	-1.04	2.20	-2.67**	142.33	133.67	145.33	140.44	2.96**	-1.94	6.01**	2.34
Sweta x LCK 88062	59.33	58.67	77.33	65.11	-0.70	0.21	2.48*	0.66	148.33	128.33	141.33	139.33	6.38**	-2.92	5.95**	3.14
LMH62 x DPL – 21	71.67	61.67	84.0	72.44	0.10	-1.32*	9.34**	2.71**	149.00	135.67	152.33	145.67	5.21**	9.64*	9.62**	8.16**

Table Contd...

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J - 23	61.67	60.67	72.33	64.89	7.41**	-0.23	1.37	2.85**	131.33	127.33	141.00	133.22	-0.34	5.14	4.20**	3.00*
LMH 62 x RLC - 6	54.33	62.33	70.67	62.44	-4.98**	1.40	2.98**	-0.20	133.67	124.33	130.67	129.56	1.02	2.86	-1.16	0.91
LMH 62 x Garima	58.67	60.00	62.67	60.44	2.52**	0.15	-3.88**	-0.40	133.67	126.00	137.33	132.35	0.80	-5.33	1.92*	-0.87
LMH 62 x KL - 43	64.00	61.33	66.33	63.89	0.58	1.46**	0.84	0.96	143.00	134.67	144.33	140.61	6.27**	6.36	3.87**	5.50**
LMH62xLCK 88062	51.57	59.00	77.67	62.78	-6.29**	-0.96	5.79**	-0.48	145.00	127.33	136.00	136.11	5.69**	3.39	-0.52	2.85*
DPL - 21 x J 23	73.00	65.67	84.33	74.33	1.77*	-1.01	2.26*	1.01*	146.33	136.33	143.00	141.89	3.35**	2.22	-2.71**	0.95
DPL - 21 x RLC - 6	73.33	71.00	69.67	71.33	-2.95**	4.29**	-9.13**	-2.60**	149.33	137.33	142.67	143.11	5.38**	3.94	1.92*	3.75**
DPL - 21 x Garima	77.33	69.00	84.33	76.84	4.21**	3.38**	6.68**	4.76**	144.33	138.00	145.67	142.67	0.16	8.75*	1.34	3.42*
DPL - 21 x KL - 43	85.67	64.00	71.67	73.78	5.27**	-1.65**	-4.93**	-0.44	151.67	135.00	154.67	147.11	3.63**	-5.22	5.29**	1.23
DPL-21xLCK 88062	73.00	69.00	84.67	75.56	-1.92*	3.27**	1.68	1.01*	149.33	139.67	146.33	145.11	-1.29	3.81	0.90	1.14
J - 23 x RLC - 6	61.33	64.67	85.67	70.56	2.35**	0.04	10.57**	4.32**	134.00	128.33	139.67	134.00	2.16**	-1.22	4.84**	1.93
J - 23 x Garima	59.33	63.67	73.00	65.33	3.52**	0.13	-0.96	0.89	134.00	130.00	140.67	134.89	1.94**	4.58	2.26**	2.93*
J - 23 x KL - 43	58.00	64.67	69.00	63.89	-5.09**	1.10*	-3.91**	-2.63**	140.33	141.00	144.67	142.00	4.41**	4.61	1.20	3.41*
J - 23 x LCK 88062	54.67	64.33	77.33	65.44	-2.95**	0.68	-1.96	-1.41**	142.67	127.67	140.33	136.89	4.16**	-4.36	0.81	0.20
RLC 6 x Garima	56.33	62.67	69.33	62.78	-4.54**	-0.90	-1.35	-2.26**	135.00	132.00	132.67	133.22	1.96**	7.31	-0.77	2.83
RLC 6 x KL - 43	67.00	63.33	69.67	66.67	-1.15	-0.26	0.04	-0.46	134.33	137.33	139.67	137.11	-2.56**	1.67	1.17	0.09
RLC 6 x LCK 88062	64.00	62.33	75.00	67.11	1.33	-1.35*	-1.02	-0.35	139.33	137.67	133.00	136.67	-0.15	6.36	-1.55*	1.56
Garima x KL - 43	69.00	62.33	68.00	66.56	4.02**	-0.18	-0.16	1.23	135.33	138.00	142.67	138.67	-1.79*	6.47	0.59	1.76
GarimaxLCK 88062	52.67	61.67	77.00	63.78	-6.84**	-0.93	2.12	-1.88**	139.67	133.33	141.00	138.00	-0.04	6.17	2.7**	3.00*
KL 43 x LCK 88062	73.3	62.67	71.00	69.00	6.55**	0.04	-2.82*	1.26*	144.67	138.33	146.33	143.1	1.10	0.19	3.15**	1.48
S.E. (m.diff.) ±	0.13	0.08	0.17	0.07					0.11	0.62	0.11	0.21				
S.E. (S_{ij}) ±					0.86	0.55	1.13	0.51					0.72	4.21	0.77	1.45
S.E. (S_{ij} - S_{ik}) ±					1.26	0.80	1.66	0.74					1.06	6.19	1.13	2.13

Table Contd....

Cross Combination	3 Plant height (Cm)								4. Tech. Plant height (Cm)							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	87.13	83.87	74.19	81.73	2.86	0.92	-1.11	0.89	54.42	43.79	44.3	47.55	0.16	-8.93	-4.30	-4.36**
Neelum x Sweta	70.73	84.86	71.20	75.50	-9.76**	-1.81	-6.89**	-6.15**	45.64	50.90	45.72	47.42	-2.32	-1.12	-3.56	-2.34
Neelum x LMH-62	62.77	78.04	79.00	73.27	-8.84**	4.61	3.43	-0.27	51.40	56.99	57.58	55.33	1.16	-0.47	8.12**	2.94*
Neelum x DPL-21	89.73	84.86	88.33	87.64	-0.67	-0.73	-0.52	-0.64	58.61	57.25	59.35	58.40	-5.42**	-1.89	-2.78	-3.36*
Neelum x J-23	83.47	81.82	78.22	81.17	0.31	-3.78	-0.98	-1.49	56.41	57.85	48.74	54.33	2.57	1.77	-1.51	0.94
Neelum x RLC-6	80.40	82.42	80.81	81.21	9.05**	2.07	-0.32	3.60*	52.57	51.27	45.79	49.88	2.63	-2.90	-2.41	-0.89
Neelum x Garima	79.57	81.13	72.26	77.65	-2.25	-1.52	-1.65	-1.80	53.23	57.50	52.19	54.31	-2.22	-0.09	1.42	-0.30
Neelum x KL-43	83.37	92.42	88.45	88.08	-1.63	3.52	4.44*	2.11	54.23	78.64	60.29	64.39	-3.73	14.62**	3.11	4.67**
Neelum xLCK88062	90.77	82.80	87.20	86.92	2.10	-1.65	3.83	1.43	69.05	64.03	60.35	64.48	8.01**	4.47*	0.85	4.44**
Shubhra x Sweta	75.07	79.40	75.02	76.49	-0.88	0.04	6.71**	1.96	46.40	48.36	45.72	46.83	0.93	1.02	3.04	1.66
Shubhra x LMH-62	61.13	70.84	69.57	67.18	-5.92	4.44	3.78	0.77	45.56	57.05	41.99	48.20	-2.19	4.27*	-0.87	0.40
Shubhra x DPL-21	85.17	79.33	94.40	86.30	-0.69	0.75	15.33**	5.13**	60.31	62.80	75.74	66.28	-1.23	8.34**	20.22**	9.11**
Shubhra x J-23	82.73	78.94	65.88	75.85	4.13	0.36	-3.54	0.32	52.36	51.52	42.50	48.79	1.01	0.12	-1.15	-0.01
Shubhra x RLC-6	60.23	71.51	69.26	67.00	-6.57	-1.82	-2.09	-3.49*	49.11	51.39	41.33	47.28	1.67	1.91	-0.26	1.10
Shubhra x Garima	76.4	73.50	66.86	72.25	-0.86	-2.12	2.74	-0.08	52.80	55.06	42.44	50.10	-0.16	2.15	-1.72	0.09
Shubhra x KL-43	80.97	79.57	65.43	75.32	0.52	-2.31	-8.79**	-3.53*	53.16	61.95	45.07	53.39	-2.32	2.61	-5.51	-1.74
ShubhraxLCK88062	89.83	80.04	67.49	79.12	5.72	2.62	-6.10**	0.74	58.64	54.88	47.42	53.65	0.09	0.00	-5.47	-1.79
Sweta x LMH – 62	65.50	71.10	68.62	68.41	2.21	1.26	0.05	1.17	42.36	48.34	42.68	44.46	0.91	-3.74	-0.73	-1.19
Sweta x DPL – 21	83.57	83.33	78.49	81.80	1.49	1.33	-3.36	-0.18	44.11	60.95	48.65	51.27	-11.02**	7.20**	-7.43**	-3.75**
Sweta x J 23	75.97	82.50	80.74	79.74	1.13	0.49	8.54**	3.39*	51.25	51.19	44.20	48.88	6.20**	0.49	-0.01	2.23
Sweta x RLC – 6	61.80	80.39	72.53	71.57	-1.23	3.63	-1.60	0.26	40.53	48.45	44.25	44.41	-0.61	-0.33	2.10	0.39
Sweta x Garima	77.13	78.31	71.51	75.65	3.64	-0.74	4.59*	2.50	52.67	50.88	48.24	50.60	6.01**	-1.32	3.52	2.74*
Sweta x KL – 43	82.50	84.01	74.85	80.45	5.83	-1.30	-2.15	0.79	53.43	51.65	52.34	52.48	4.26*	-6.99**	1.21	-0.50
Sweta x LCK 88062	77.13	79.25	73.23	76.54	-3.21	-1.61	-3.14	-2.66	45.75	59.48	56.70	53.98	-6.50**	5.30*	3.25	0.69
LMH62 x DPL – 21	68.80	68.17	74.33	70.43	-4.39	-0.87	-5.00*	-3.42*	57.48	61.94	52.61	57.34	-0.03	2.75	-3.65	-0.31

Table Contd....

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J - 23	63.80	73.89	69.07	68.92	-2.15	4.84	-0.62	0.69	53.48	53.97	41.79	49.75	6.15**	-2.17	-2.60	0.46
LMH 62 x RLC - 6	63.83	65.17	69.51	66.17	9.69**	1.37	-2.11	2.98	42.42	56.87	42.19	47.16	-1.00	2.65	-0.14	0.50
LMH 62 x Garima	64.60	71.10	68.86	68.19	0.00	5.01	4.46*	3.15	53.26	57.66	44.73	51.88	4.31*	0.01	-0.17	1.39
LMH 62 x KL - 43	66.87	72.91	71.06	70.28	-0.92	0.56	-3.43	-1.26	54.12	66.01	53.69	57.94	2.67	1.93	2.38	2.33
LMH62xLCK 88062	73.90	70.51	71.11	71.84	2.44	2.61	-2.75	0.77	46.77	60.03	58.10	54.97	-7.77**	0.41	4.47	-0.96
DPL - 21 x J 23	84.90	81.74	77.46	81.37	0.16	0.52	-5.50**	-1.61	64.08	55.85	57.04	58.99	2.97	-1.46	-0.01	0.33
DPL - 21 x RLC - 6	72.57	73.58	80.52	75.56	-0.37	-2.39	-4.37**	-2.38	51.93	56.29	53.01	53.74	-5.28*	0.40	-1.99	-2.29
DPL - 21 x Garima	82.27	81.43	67.16	76.95	-1.13	3.16	-10.51**	-2.83	62.80	59.97	54.38	59.05	0.08	0.65	-3.18	-0.82
DPL - 21 x KL - 43	84.27	78.11	96.26	86.21	-2.31	-6.41	8.49**	-0.08	74.85	68.23	71.60	71.56	9.62**	2.48	7.63**	6.58**
DPL-21xLCK 88062	90.80	80.60	92.44	87.95	0.55	0.53	5.30**	2.93	72.76	58.21	48.62	59.86	4.44*	-3.08	-17.67**	-5.44**
J - 23 x RLC - 6	48.17	78.32	76.88	67.79	-17.52**	2.34	1.63	-4.52**	52.37	52.75	43.60	49.58	5.35**	-0.09	0.48	1.91
J - 23 x Garima	76.77	75.24	66.79	72.93	0.61	-3.03	-1.23	-1.22	54.42	63.91	45.05	54.46	1.87	7.64**	-0.64	2.96*
J - 23 x KL - 43	82.37	83.23	78.59	81.40	3.03	-1.30	0.47	0.94	53.39	62.83	54.46	56.89	-1.66	0.12	2.36	0.27
J - 23 x LCK 88062	83.90	81.33	77.01	80.75	0.89	1.25	-0.47	0.56	64.48	61.74	62.77	63.00	6.35**	3.49	8.36**	6.07**
RLC 6 x Garima	72.93	71.12	67.79	70.62	8.59*	-1.90	-2.16	1.51	52.23	56.95	42.89	50.69	3.59	2.60	-0.74	1.82
RLC 6 x KL - 43	64.83	75.56	84.13	74.84	-2.69	-3.72	4.08*	-0.78	55.95	64.04	48.16	56.05	4.81*	3.26	-1.89	2.06
RLC 6 x LCK 88062	66.90	74.42	81.43	74.25	-4.30	-0.40	2.01	-0.90	50.25	58.15	57.45	55.28	-3.98	1.83	5.09	0.98
Garima x KL - 43	75.87	81.15	72.45	76.49	-2.12	-0.43	-0.38	-0.97	53.76	64.79	51.33	56.63	-2.90	0.58	-1.29	-1.20
GarimaxLCK 88062	76.47	79.18	70.94	75.53	-5.19	2.06	-1.25	-1.46	55.40	59.22	57.15	57.26	-4.39*	-0.52	2.21	-0.88
KL 43 x LCK 88062	84.20	80.88	82.98	82.69	-0.64	-2.50	0.70	-0.81	62.81	64.72	64.40	63.98	0.56	-1.46	3.05	0.72
S.E. (m.diff.) ±	0.50	0.42	0.29	0.24					0.30	0.31	0.42	0.20				
S.E. (S_{ij}) ±					3.40	2.84	1.98	1.62					2.07	2.12	2.85	1.37
S.E. (S_{ij} - S_{ik}) ±					5.00	4.18	2.91	2.38					3.05	3.12	4.19	2.02

Table Contd....

Cross Combination	5. No. of tillers/plant								6. No. of branches/plant							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	5.90	7.62	4.93	6.15	0.26	11.12**	-0.51	3.62**	30.00	28.76	19.32	26.03	-4.40**	-1.42	-0.30	-2.04
Neelum x Sweta	5.76	4.18	4.01	4.65	-0.19	-1.10	-0.24	-0.51	32.00	35.52	18.70	28.74	-2.29	4.92*	-0.43	0.73
Neelum x LMH-62	6.87	4.03	4.80	5.23	1.20**	-0.77	0.31	0.25	33.33	30.49	25.24	29.69	-1.96	-0.20	1.31	-0.28
Neelum x DPL-21	7.07	4.72	5.08	5.62	0.06	-1.37	-0.26	-0.52	28.67	23.45	22.27	24.80	-2.71	-5.62**	0.61	-2.57*
Neelum x J-23	4.70	4.23	5.28	4.74	-0.16	-0.73	0.39	-0.17	33.00	30.62	21.38	28.33	-0.87	2.83	-1.34	0.20
Neelum x RLC-6	3.73	4.24	4.55	4.18	-1.44**	-0.63	0.23	-0.61	30.00	39.50	19.77	29.76	-2.57	10.71**	-1.78	2.12
Neelum x Garima	5.62	4.83	4.88	5.11	-0.24	-0.78	0.05	-0.32	32.33	29.24	22.04	27.87	1.54	2.22	0.38	1.38
Neelum x KL-43	8.75	4.45	5.56	6.25	2.32**	-1.24	0.39	0.49	35.33	21.06	24.81	27.07	5.38**	**-3.67**	3.58	1.76
Neelum xLCK88062	7.28	5.22	5.12	5.87	0.18	-0.92	0.33	-0.14	34.33	22.00	16.56	24.30	5.29**	-0.48	-0.39	1.48
Shubhra x Sweta	4.68	5.20	5.55	5.14	-0.91**	-0.68	0.43	-0.39	41.33	41.01	20.25	34.20	2.35	6.54**	3.48	4.12**
Shubhra x LMH-62	6.80	4.20	4.81	5.27	1.48**	-1.20	-0.56	-0.04	42.67	39.10	20.95	34.24	2.68	4.54*	-0.63	2.20
Shubhra x DPL-21	7.57	5.23	5.93	6.24	0.92**	-1.45	-0.29	-0.28	33.67	37.19	19.38	30.08	-2.40	4.24*	0.07	0.64
Shubhra x J-23	3.93	4.0	5.98	4.64	-0.58**	-1.57	0.22	-0.64	42.33	33.62	20.43	32.13	3.77*	1.96	0.06	1.93
Shubhra x RLC-6	4.52	5.10	4.73	4.78	-0.30	-0.37	-0.47	-0.38	47.33	35.56	20.87	34.59	10.07**	2.89	1.67	4.88**
Shubhra x Garima	3.72	5.71	8.35	5.93	-1.79**	-0.50	2.64**	0.12	38.00	36.24	17.99	30.74	2.52	5.34*	-1.31	2.18
Shubhra x KL-43	6.0	6.18	5.97	6.05	-0.08	-0.11	-0.08	-0.09	37.33	26.65	16.74	26.91	2.68	-1.95	-2.14	-0.47
ShubhraxLCK88062	6.87	5.55	5.68	6.03	0.11	-1.19	0.01	-0.35	32.67	20.02	13.07	21.92	-1.07	-6.33**	-1.52	-2.97*
Sweta x LMH – 62	4.72	4.68	4.40	4.60	-0.91**	0.51	0.23	-0.05	44.00	35.23	20.41	33.21	4.13**	0.25	-0.67	1.23
Sweta x DPL – 21	7.48	5.12	5.78	6.13	0.53*	-0.33	0.77	0.32	38.67	34.26	18.12	30.35	2.71	0.89	-0.69	0.97
Sweta x J 23	3.90	4.33	4.90	4.38	-0.91**	0.00	0.34	-0.19	43.00	33.86	19.73	32.20	4.54**	1.78	-0.14	2.06
Sweta x RLC – 6	6.13	4.73	4.18	5.02	1.01**	0.50	0.18	0.56	38.67	34.47	19.23	30.79	1.52	1.39	0.54	1.15
Sweta x Garima	5.68	5.58	3.99	5.09	-0.12	0.60	-0.52	-0.01	34.67	31.48	18.25	28.13	-0.71	0.17	-0.55	-0.36
Sweta x KL – 43	6.92	4.33	4.94	5.40	0.54**	-0.73	0.09	-0.03	34.00	31.96	17.45	27.80	-0.54	2.94	-0.93	0.49
Sweta x LCK 88062	7.78	4.65	4.03	5.49	0.73**	-0.86	-0.44	-0.19	36.33	21.04	15.51	24.30	2.71	-5.73**	1.42	-0.53
LMH62 x DPL – 21	6.47	5.07	5.19	5.57	-0.21	0.09	-0.07	-0.07	40.33	35.94	22.12	32.80	3.38*	2.48	-1.50	1.45

Table Contd....

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J - 23	4.77	4.07	4.82	4.55	0.23	0.21	0.01	0.15	43.00	34.81	29.33	35.71	3.54*	2.64	4.65*	3.61**
LMH 62 x RLC - 6	5.50	4.23	4.37	4.70	0.65**	0.47	0.13	0.42	40.67	32.57	18.92	30.72	2.52	-0.60	-4.59*	-0.89
LMH 62 x Garima	5.73	4.28	4.59	4.87	0.20	-0.22	-0.16	-0.06	35.33	31.16	26.25	30.92	-1.04	-0.24	2.64	0.45
LMH 62 x KL - 43	5.25	5.13	5.59	5.32	-0.86**	0.55	0.50	0.07	34.33	30.77	21.47	28.86	-1.21	1.66	-1.71	-0.42
LMH62xLCK 88062	5.62	5.40	4.76	5.26	-1.17**	0.37	0.05	-0.25	37.00	32.97	17.33	29.10	2.38	6.11	-1.57	2.31*
DPL - 21 x J 23	5.90	5.13	5.81	5.61	0.03	-0.01	0.15	0.06	35.00	34.10	21.89	30.33	-0.54	3.54	-0.52	0.83
DPL - 21 x RLC - 6	4.77	4.33	4.58	4.56	-1.41**	-0.71	-0.52	-0.88	45.33	35.39	22.74	34.49	11.10**	3.83	1.51	5.48**
DPL - 21 x Garima	6.63	6.63	4.96	6.08	-0.23	0.84	-0.64	-0.01	31.33	24.85	20.74	25.64	-1.12	-4.94**	-0.59	-2.22
DPL - 21 x KL - 43	6.83	6.22	6.60	6.55	-0.60**	0.35	0.66	0.14	33.67	32.07	24.67	30.14	2.04	4.57*	3.76	3.46**
DPL-21xLCK 88062	8.40	7.20	5.62	7.07	0.29	0.88	0.07	0.41	29.67	29.56	17.72	25.65	-1.04	4.31*	1.09	1.45
J - 23 x RLC - 6	3.67	4.23	4.50	4.13	-0.37	0.31	-0.14	-0.08	34.00	26.25	22.15	27.47	-2.73	-4.02	-0.14	-2.30*
J - 23 x Garima	4.37	5.33	4.90	4.93	-0.36	0.86	-0.25	0.09	36.33	32.18	22.96	30.49	1.38	3.68	0.56	1.87
J - 23 x KL - 43	5.20	4.33	4.97	4.83	-0.09	-0.42	-0.52	-0.34	36.67	28.31	22.74	29.24	2.54	2.10	0.77	1.80
J - 23 x LCK 88062	7.23	7.30	5.31	6.61	1.26**	2.10	0.20	1.19*	33.67	26.71	17.24	25.87	0.46	2.75	-0.45	0.92
RLC 6 x Garima	7.70	4.77	4.80	5.75	2.67**	0.20	0.21	1.03	36.00	33.25	21.40	30.22	2.35	3.74	0.18	2.09
RLC 6 x KL - 43	4.40	4.53	4.79	4.57	-1.20**	-0.12	-0.13	-0.43	27.33	26.45	19.76	24.51	-5.48**	-0.76	-1.04	-2.43*
RLC 6 x LCK 88062	6.02	4.77	4.91	5.23	-0.26	-0.33	0.36	-0.08	27.33	25.71	17.78	23.61	-4.57**	0.74	1.26	-0.86
Garima x KL - 43	6.72	5.93	5.00	5.88	0.43*	0.54	-0.43	0.18	30.67	27.32	21.91	26.63	-0.37	1.88	1.01	0.84
GarimaxLCK 88062	6.08	4.23	5.07	5.13	-0.88**	-1.61	0.02	-0.83	31.33	24.05	16.27	23.88	1.21	0.85	-0.35	0.57
KL 43 x LCK 88062	7.05	6.03	6.08	6.39	-0.49**	0.11	0.70	0.11	31.33	21.90	17.07	23.44	2.04	1.00	0.88	1.31
S.E. (m.diff.) ±	0.03	0.24	0.06	0.08					0.22	0.31	0.34	0.17				
S.E. (S_{ij}) ±					0.21	1.65	0.43	0.57					1.48	2.09	2.34	1.16
S.E. $(S_{ij} - S_{ik})$ ±					0.31	2.43	0.64	0.84					2.17	3.07	3.44	1.70

Table Contd......

Cross Combination	7. No. of Capsules/plant								8. No. of Seeds/Capsule							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	88.16	43.79	51.02	60.99	1.62	-0.88	0.43	0.39	8.02	6.25	8.36	7.54	-0.41**	-0.25**	0.13	-0.18**
Neelum x Sweta	75.50	53.10	51.59	60.06	-2.82	1.83	-2.29	-1.10	7.87	7.17	7.48	7.51	-0.03	0.38**	-0.42**	-0.02
Neelum x LMH-62	76.07	56.63	53.89	62.20	-5.37*	-7.30**	-1.51	-4.73**	8.20	7.21	7.75	7.72	-0.05	0.42**	-0.14	0.08
Neelum x DPL-21	85.20	48.50	57.82	63.84	2.71	-2.55	2.01	0.72	7.81	6.18	7.40	7.13	-0.30*	-0.38**	-0.33**	-0.34**
Neelum x J-23	84:76	49.81	55.09	63.22	0.15	0.24	1.41	0.60	9.03	6.99	8.81	8.28	0.45**	0.14	0.60**	0.40**
Neelum x RLC-6	72.94	52.16	49.30	58.13	-0.36	-9.61**	0.56	-3.13*	8.66	6.02	7.75	7.48	-0.07	-0.46**	0.47**	-0.02
Neelum x Garima	72.25	61.71	60.28	64.75	-5.58*	8.73**	9.89**	4.35**	8.12	6.06	7.80	7.33	-0.26	-0.47**	-0.17	-0.30**
Neelum x KL-43	84.90	61.49	47.45	64.61	1.19	5.12**	-2.95	1.12	8.72	5.98	8.01	7.57	0.64**	-0.51**	-0.20*	-0.02
Neelum xLCK88062	67.25	57.50	50.92	58.56	-8.33**	3.76*	0.31	-1.42	9.25	6.46	8.12	7.94	0.68**	-0.19*	0.00	0.16*
Shubhra x Sweta	71.71	50.76	47.64	56.70	-7.65**	-1.98	-2.33	-3.99**	8.23	6.57	8.51	7.77	0.30*	0.40**	0.59**	0.43**
Shubhra x LMH-62	76.40	74.88	58.18	69.82	-6.08*	9.48**	6.68**	3.36**	-9.04	6.26	7.93	7.74	0.76**	0.10	0.02	0.29**
Shubhra x DPL-21	89.99	59.81	57.15	69.18	6.46**	7.29**	5.85*	6.53**	7.43	5.90	7.34	6.89	-0.70**	-0.03	-0.41**	-0.38**
Shubhra x J-23	93.98	50.69	47.43	64.03	8.34**	-0.35	-2.34	1.88	8.50	6.13	8.21	7.61	-0.11	-0.08	-0.03	-0.07
Shubhra x RLC-6	84.85	74.93	46.94	68.82	10.25**	11.70**	2.12	8.02**	9.03	6.02	6.77	7.27	0.27	0.17	-0.53**	-0.03
Shubhra x Garima	75.17	57.37	44.94	59.16	-3.70	2.93	-1.54	-0.77	9.07	5.75	8.07	7.63	0.65**	-0.15	0.07	0.19**
Shubhra x KL-43	85.82	49.16	47.49	60.83	1.08	-8.66**	1.00	-2.20	7.93	5.96	8.25	7.38	-0.17	0.09	0.02	-0.02
ShubhraxLCK88062	72.31	53.58	45.57	57.15	-4.31	-1.62	-1.15	-2.36	8.78	6.08	8.07	7.65	0.18	0.06	-0.07	0.06
Sweta x LMH – 62	76.08	74.19	55.44	68.57	1.82	2.20	0.65	1.56	7.98	6.29	7.49	7.25	0.22	-0.16	-0.08	-0.01
Sweta x DPL – 21	74.23	59.62	57.31	63.72	-1.08	0.50	2.12	0.51	8.12	6.11	7.77	7.34	0.51**	-0.11	0.36**	0.25**
Sweta x J 23	81.72	56.42	66.58	68.24	4.29	-1.22	13.52**	5.53**	7.87	6.61	7.45	7.31	-0.20	0.09	-0.45**	-0.19**
Sweta x RLC – 6	64.69	73.99	44.56	61.08	-1.43	4.16*	-3.55	-0.27	7.95	6.04	7.05	7.02	-0.29	-0.10	0.09	-0.10
Sweta x Garima	71.05	61.50	45.61	59.39	0.40	0.46	-4.16	-1.10	7.82	6.20	7.68	7.23	-0.07	0.00	0.02	-0.02
Sweta x KL – 43	75.30	70.79	53.69	66.76	-0.73	6.37**	3.91	3.18*	7.57	6.10	8.30	7.32	-0.01	-0.06	0.40**	0.11
Sweta x LCK 88062	76.26	60.92	49.76	62.31	7.85**	-0.88	-0.24	2.24	7.72	6.42	8.02	7.39	-0.36*	0.10	0.21*	-0.01
LMH62 x DPL – 21	81.83	60.75	56.39	66.33	3.40	-11.03**	-0.32	-2.65*	8.07	5.88	7.51	7.15	0.11	-0.34**	0.10	-0.04

Table Contd....

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J - 23	79.93	79.53	55.70	71.72	-0.61	9.23**	1.11	3.24*	8.43	7.12	7.94	7.83	0.01	0.61**	0.05	0.22**
LMH 62 x RLC - 6	71.90	88.40	44.94	68.41	2.67	5.91**	-4.70*	1.29	8.62	6.15	6.87	7.21	0.04	0.01	-0.09	-0.02
LMH 62 x Garima	78.34	81.20	55.82	71.79	4.57	7.51**	4.53	5.54**	8.29	6.18	7.79	7.42	0.05	-0.02	0.14	0.06
LMH 62 x KL - 43	78.80	81.69	46.97	69.15	-0.84	4.61*	-4.33	-0.19	7.81	6.06	7.86	7.24	-0.11	-0.10	-0.03	-0.08
LMH62xLCK 88062	76.14	76.69	54.74	69.19	4.62	2.24	3.21	3.36**	8.05	6.26	7.83	7.38	-0.37**	-0.05	0.02	-0.13
DPL - 21 x J 23	81.11	63.90	54.14	66.38	-0.49	6.47**	-0.84	1.71	8.84	6.47	7.83	7.71	0.56**	0.20*	0.09	0.28**
DPL - 21 x RLC - 6	67.45	74.84	53.07	65.12	-2.84	5.23**	3.03	1.81	9.07	6.01	6.63	7.24	0.63**	0.11	-0.17	0.19**
DPL - 21 x Garima	70.72	61.65	53.24	61.87	-4.10	0.83	1.55	-0.57	7.90	6.21	7.66	7.26	-0.20	0.25**	0.16	0.07
DPL - 21 x KL - 43	81.81	68.99	48.54	66.44	1.10	4.78**	-3.17	0.90	8.05	6.13	7.69	7.29	0.27	0.21*	-0.05	0.14
DPL-21xLCK 88062	73.03	65.46	47.19	61.89	0.45	3.88*	-4.74*	-0.14	8.35	6.21	8.14	7.57	0.08	0.13	0.50**	0.23**
J - 23 x RLC - 6	72.04	72.60	43.86	62.83	-0.36	4.47*	-4.05	0.02	9.00	6.20	6.95	7.38	0.10	0.01	-0.34**	-0.08
J - 23 x Garima	69.94	60.03	43.11	57.96	-6.99**	0.69	-5.66*	-3.98**	9.12	6.11	7.74	7.65	0.55**	-0.14	-0.24*	0.06
J - 23 x KL - 43	82.44	62.41	48.16	64.34	-0.38	-0.32	-1.41	-0.70	8.22	6.03	8.59	7.62	-0.03	-0.18*	0.37**	0.06
J - 23 x LCK 88062	74.29	66.29	47.63	62.74	-0.40	6.19**	-2.16	1.21	8.41	6.36	8.17	7.65	-0.34	-0.01	0.04	-0.10
RLC 6 x Garima	64.13	72.73	46.51	61.12	-1.49	1.19	1.89	0.53	8.85	6.04	7.17	7.35	0.13	0.17	0.12	0.14*
RLC 6 x KL - 43	66.38	78.60	45.41	63.46	-5.12*	3.68*	0.77	-0.22	8.31	5.98	7.53	7.27	-0.09	0.14	0.24**	0.10
RLC 6 x LCK 88062	64.25	73.17	50.64	62.69	0.87	0.88	5.78*	2.51*	9.06	6.20	6.92	7.39	0.16	0.20*	-0.28**	0.03
Garima x KL - 43	78.14	66.17	51.15	65.42	2.90	0.04	4.86*	2.60*	8.03	6.30	8.10	7.48	-0.03	0.40**	0.13	0.17*
GarimaxLCK 88062	67.05	63.44	47.48	59.32	-0.87	-0.05	0.97	0.02	8.09	6.06	7.99	7.38	-0.47**	0.01	0.10	-0.12
KL 43 x LCK 88062	70.22	69.97	48.03	62.74	-3.58	3.08	1.51	0.34	7.98	6.02	8.09	7.37	-0.26	0.00	-0.04	-0.10
S.E. (m.diff.) ±	0.35	0.26	0.35	0.19					0.02	0.01	0.01	0.01				
S.E. (S_{ij}) ±					2.40	1.80	2.37	1.27					0.15	0.09	0.09	0.07
S.E. (S_{ij} - S_{ik}) ±					3.53	2.64	3.48	1.87					0.22	0.13	0.14	0.10

Table Contd.....

Cross Combination	9. 1000 Seed weight (g)								10. Harvest Index (%)							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	9.38	7.08	7.63	8.03	0.85**	0.09	-0.31**	0.21**	35.58	28.31	32.36	32.09	2.36*	-0.06	-2.00	0.10
Neelum x Sweta	9.55	7.24	8.54	8.44	0.55**	-0.08	0.05	0.17*	33.94	30.84	32.96	32.58	3.21**	0.79	2.71	2.23*
Neelum x LMH-62	8.62	7.08	7.68	7.80	-0.16	0.09	-0.66**	-0.24**	35.54	29.59	31.89	32.34	-0.24	-1.88	-2.23	-1.45
Neelum x DPL-21	8.18	7.08	7.66	7.64	-0.47**	0.30	-0.06	-0.08	28.28	26.89	28.79	27.99	-2.13*	-0.71	0.84	-0.67
Neelum x J-23	8.38	7.06	8.54	7.99	-0.28**	0.12	0.35**	0.06	32.35	26.56	32.96	30.62	-0.02	0.49	0.56	0.34
Neelum x RLC-6	6.82	6.78	8.42	7.34	-0.68**	0.13	0.11	-0.14*	29.68	29.36	30.86	29.97	-1.91	2.03	0.02	0.05
Neelum x Garima	8.56	7.17	9.11	8.28	-0.20**	0.38*	0.05	0.08	33.18	32.36	33.43	32.99	0.43	0.39	0.50	0.44
Neelum x KL-43	7.73	6.16	8.38	7.42	-0.66**	-0.68**	0.28**	-0.35**	28.77	30.01	29.69	29.49	-1.64	1.16	0.49	0.01
Neelum xLCK88062	7.52	7.56	8.05	7.71	-0.68**	0.17	-0.31**	-0.27**	34.51	31.06	33.49	33.02	1.53	-0.20	1.35	0.90
Shubhra x Sweta	7.93	7.22	8.07	7.74	-0.46**	0.20	0.20*	-0.02	29.34	30.17	30.36	29.96	-1.58	2.32	-2.32	-0.53
Shubhra x LMH-62	7.88	7.22	7.26	7.46	-0.30**	0.52**	-0.46**	-0.08	37.93	29.02	35.90	34.62	1.96	-0.26	0.36	0.68
Shubhra x DPL-21	8.00	7.13	7.40	7.51	-0.05	0.63**	0.30**	0.29**	30.81	25.30	32.18	29.43	0.21	-0.10	1.81	0.64
Shubhra x J-23	8.03	6.00	7.46	7.16	-0.03	-0.65**	-0.12	-0.27**	30.85	24.16	36.82	30.61	-1.71	0.29	2.00	0.19
Shubhra x RLC-6	6.92	6.01	8.14	7.02	0.02	-0.34	0.45**	0.04	31.23	24.88	33.41	29.84	-0.55	-0.25	0.14	-0.22
Shubhra x Garima	8.08	6.17	8.92	7.72	-0.08	-0.33	0.47**	0.02	31.34	28.08	35.61	31.68	-1.62	-1.68	0.25	-1.01
Shubhra x KL-43	7.85	6.11	7.38	7.11	0.06	-0.44*	-0.10	-0.16*	30.58	28.30	33.53	30.80	-0.02	1.65	1.91	1.18
ShubhraxLCK88062	7.83	7.18	7.71	7.57	0.23**	0.09	-0.03	0.09	34.43	30.43	34.08	32.98	1.25	1.37	-0.48	0.72
Sweta x LMH – 62	8.78	7.16	7.49	7.81	0.14	0.13	-0.78**	-0.17**	29.26	33.27	34.28	32.50	-3.53**	2.31	1.85	0.21
Sweta x DPL – 21	8.39	6.35	7.36	7.37	-0.13	-0.47**	-0.29**	-0.29**	29.65	26.38	27.05	27.69	1.54	-0.69	0.78	0.54
Sweta x J 23	8.33	7.36	9.15	8.28	-0.20*	0.38*	1.03**	0.40**	29.44	24.49	31.63	28.52	-0.63	-1.05	0.92	-0.25
Sweta x RLC – 6	6.79	6.16	8.35	7.10	-0.58**	-0.52**	0.11	-0.33**	30.48	25.60	27.95	28.01	1.20	-1.21	-1.21	-0.41
Sweta x Garima	8.76	7.16	9.13	8.35	0.14	0.34	0.13	0.20**	31.65	31.26	28.78	30.56	1.20	-0.18	-2.47	-0.49
Sweta x KL – 43	7.99	7.43	8.24	7.89	-0.27**	0.55**	0.21*	0.17*	30.51	29.10	27.93	29.18	2.41*	0.78	0.41	1.20
Sweta x LCK 88062	7.61	7.37	8.08	7.69	-0.46**	-0.05	-0.21*	-0.24**	31.02	31.14	31.96	31.37	0.35	0.40	1.51	0.75
LMH62 x DPL – 21	8.44	6.30	7.97	7.57	0.14	-0.20	0.48**	0.14*	34.10	29.59	29.26	30.98	0.93	1.09	-0.87	0.39

Table Contd....

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	8.39	6.45	7.62	7.49	0.08	-0.20	-0.35**	-0.16*	34.38	24.46	34.92	31.25	-0.74	-2.51	0.34	-0.97
LMH 62 x RLC - 6	6.88	6.42	7.72	7.01	-0.27**	0.06	-0.37**	-0.19**	36.58	33.39	34.91	34.96	2.24*	5.16**	1.88	3.09**
LMH 62 x Garima	8.57	7.03	10.17	8.57	0.10	0.53**	1.33**	0.65**	35.76	34.48	35.20	35.15	0.25	1.61	0.09	0.65
LMH 62 x KL - 43	8.03	6.36	9.99	8.12	-0.01	-0.20	2.11**	0.63**	34.29	29.68	32.00	31.99	1.14	-0.06	0.62	0.56
LMH62xLCK 88062	8.00	7.23	8.49	7.91	0.15	0.13	0.35**	0.21**	34.92	31.78	33.68	33.46	-0.81	-0.38	-0.64	-0.61
DPL - 21 x J 23	8.44	6.30	7.23	7.33	0.26**	-0.14	-0.12	0.00	29.45	21.80	28.94	26.73	-0.30	-1.29	0.53	-0.35
DPL - 21 x RLC - 6	7.02	6.27	7.41	6.90	-0.01	0.12	-0.06	0.02	30.27	26.84	29.22	28.77	1.30	2.48	2.36	2.05*
DPL - 21 x Garima	8.25	6.19	7.67	7.37	-0.04	-0.10	-0.55**	-0.23**	28.98	31.91	19.69	26.86	-1.16	2.92*	-9.25	-2.50**
DPL - 21 x KL - 43	8.00	6.46	7.24	7.23	0.09	0.11	-0.02	0.06	28.65	22.62	21.40	24.22	0.87	-3.24*	-3.82	-2.07*
DPL-21xLCK 88062	8.10	7.14	7.45	7.56	0.37**	0.25	-0.07	0.19**	30.08	29.79	28.91	29.59	-0.28	1.51	0.76	0.66
J - 23 x RLC - 6	7.23	6.40	7.86	7.16	0.19*	0.10	-0.08	0.07	32.98	22.97	31.34	29.10	2.06	0.15	0.04	0.75
J - 23 x Garima	8.43	6.27	8.06	7.59	0.14	-0.18	-0.64**	-0.22**	33.27	28.26	35.51	32.35	1.17	0.80	2.12	1.37
J - 23 x KL - 43	8.15	7.76	7.81	7.91	0.22*	1.26**	0.08	0.52**	32.91	24.04	20.41	25.79	3.17**	-0.30	-9.25**	-2.12*
J - 23 x LCK 88062	7.57	7.32	7.98	7.63	-0.17	0.28	-0.01	0.03	33.05	30.79	31.91	31.92	0.73	4.04**	-0.68	1.36
RLC 6 x Garima	6.83	6.36	8.53	7.24	-0.30**	0.21	-0.29**	-0.12	31.29	25.77	31.84	29.63	-0.02	-2.95*	0.00	-0.99
RLC 6 x KL - 43	7.02	6.21	7.19	6.81	0.26**	0.00	-0.66**	-0.13	31.07	24.86	30.11	28.68	2.11*	-0.75	2.00	1.12
RLC 6 x LCK 88062	6.92	7.17	8.51	7.53	0.34**	0.42*	0.40**	0.39**	31.48	27.48	29.14	29.36	-0.05	-0.54	-1.91	-0.83
Garima x KL - 43	8.12	6.29	8.29	7.57	0.10	-0.06	-0.31**	-0.09	31.23	30.92	34.83	32.33	1.10	0.69	4.64*	2.14*
GarimaxLCK 88062	7.92	6.56	9.66	8.05	0.09	-0.33	0.79**	0.18**	33.96	31.31	34.53	33.27	1.26	-1.34	1.40	0.44
KL 43 x LCK 88062	7.78	7.05	7.51	7.44	0.31**	0.10	-0.39**	0.01	27.68	28.79	30.93	29.13	-2.67*	-0.74	1.53	-0.62
S.E. (m.diff.) ±	0.01	0.03	0.01	0.01					0.16	0.21	0.32	0.14				
S.E. (S_{ij}) ±					0.09	0.18	0.10	0.07					1.07	1.44	2.21	0.95
S.E. (S_{ij} - S_{ik}) ±					0.13	0.26	0.14	0.11					1.57	2.11	3.25	1.39

Table Contd.....

Cross Combination	11. Fibre yield/plant (g)								12. Oil Content (%)							
	Mean Value				SCA effects				Mean value				SCA Effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	2.00	1.29	1.14	1.48	-0.32**	-0.32**	-0.41**	-0.35**	41.63	42.33	42.47	42.15	-0.80	0.71**	0.26	0.06
Neelum x Sweta	1.87	1.58	1.22	1.56	0.05	0.01	-0.31**	-0.08*	41.45	41.78	41.43	41.55	-0.93*	-0.18	-0.86**	-0.66**
Neelum x LMH-62	1.37	1.50	2.21	1.69	-0.44**	-0.44**	0.57**	-0.10**	41.75	41.59	42.38	41.91	-1.02*	-0.09	-0.26	-0.45**
Neelum x DPL-21	3.68	2.36	2.78	2.94	0.34**	-0.33**	0.19**	0.07	42.50	41.59	41.28	41.74	-0.07	0.39	0.10	0.14
Neelum x J-23	2.32	1.68	1.60	1.86	-0.06	-0.24**	-0.15*	-0.15**	43.23	40.93	41.67	41.94	1.99**	-0.16	0.82**	0.88**
Neelum x RLC-6	2.54	1.52	1.36	1.81	0.67**	-0.03	-0.22**	0.14**	42.55	43.04	44.04	43.21	0.24	0.90**	1.49**	0.87**
Neelum x Garima	1.92	1.71	1.14	1.59	-0.14*	-0.10	-0.32**	-0.19**	42.00	41.69	42.26	41.98	0.49	0.23	0.14	0.29
Neelum x KL-43	2.91	3.18	2.51	2.87	0.18**	0.60**	0.26**	0.35**	41.99	40.55	41.81	41.45	-0.12	-1.06**	-0.38*	-0.52**
Neelum xLCK88062	2.58	2.90	2.47	2.65	-0.19**	0.32**	-0.03	0.03	41.83	41.24	41.10	41.39	-0.04	0.53*	-0.78**	-0.10
Shubhra x Sweta	1.94	1.11	1.11	1.38	0.54**	-0.03	0.23**	0.24**	43.33	43.56	43.75	43.55	-0.21	0.78**	0.76**	0.44**
Shubhra x LMH-62	1.47	1.32	1.08	1.29	0.08	-0.19*	0.10	0.00	44.15	42.50	43.61	43.42	0.22	0.00	0.28	0.17
Shubhra x DPL-21	2.16	2.95	1.25	2.12	-0.75**	0.69**	-0.68**	-0.35**	43.82	41.47	41.46	42.25	0.09	-0.55*	-0.43*	-0.30
Shubhra x J-23	1.91	1.64	1.21	1.59	-0.04	0.14	0.12	0.07	42.26	42.10	40.81	41.73	-0.14	0.20	-0.74**	-0.23
Shubhra x RLC-6	1.83	1.44	1.17	1.48	0.39**	0.32**	0.24**	0.32**	43.15	43.32	43.06	43.18	-0.32	0.35	-0.19	-0.05
Shubhra x Garima	1.91	1.36	1.11	1.46	0.28**	-0.03	0.30**	0.18**	42.86	41.91	42.82	42.53	0.18	-0.37	-0.01	-0.06
Shubhra x KL-43	2.07	1.38	1.70	1.72	-0.23**	-0.78**	0.12	-0.30**	43.49	42.47	43.09	43.02	0.22	0.03	0.20	0.15
ShubhraxLCK88062	2.65	2.84	1.48	2.32	0.30**	0.68**	-0.37**	0.21**	43.03	40.59	42.44	42.02	0.00	-0.94**	-0.14	-0.86*
Sweta x LMH – 62	0.94	1.67	1.08	1.23	0.05	0.20*	0.11	0.12**	44.33	43.52	43.52	43.79	0.45	0.68**	0.10	0.41*
Sweta x DPL – 21	2.41	2.11	1.30	1.94	-0.02	-0.12	-0.62**	-0.25**	44.22	41.85	41.87	42.65	0.54	-0.51*	-0.09	-0.02
Sweta x J 23	1.93	1.62	1.33	1.63	0.47**	0.16*	0.26**	0.30**	43.06	42.09	41.41	42.18	0.71	-0.16	-0.23	0.11
Sweta x RLC – 6	0.94	1.41	1.19	1.18	-0.01	0.32**	0.28**	0.20**	43.81	42.93	43.41	43.38	0.40	-0.38	0.08	0.03
Sweta x Garima	1.24	1.41	1.09	1.25	0.10	0.06	0.30**	0.15**	42.55	42.11	43.19	42.62	-0.07	-0.51*	0.28	-0.10
Sweta x KL – 43	1.84	1.25	1.26	1.45	0.02	-0.87**	-0.31**	-0.39**	43.32	43.43	43.13	43.29	0.10	0.65**	0.16	0.30
Sweta x LCK 88062	0.93	2.77	1.57	1.76	-0.93**	0.66**	-0.26**	-0.18**	42.57	41.15	42.97	42.23	-0.42	-0.73**	0.31	-0.28
LMH62 x DPL – 21	2.43	3.22	1.63	2.43	0.02	0.63**	-0.39**	0.09*	44.03	42.19	42.46	42.89	-0.04	0.11	0.15	0.08

Table Contd........

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	1.95	1.71	1.28	1.65	0.50**	-0.11	0.10	0.16**	41.84	41.62	41.62	41.69	-0.89*	-0.34	-0.36*	-0.53**
LMH 62 x RLC - 6	0.91	1.45	1.23	1.19	-0.02	0.00	0.21**	0.06	43.53	42.86	43.72	43.37	-0.27	-0.16	0.05	-0.13
LMH 62 x Garima	1.17	1.64	1.09	1.30	0.04	0.08	0.19**	0.05	42.41	42.34	42.83	42.60	-0.60	0.20	-0.41*	-0.27
LMH 62 x KL - 43	2.06	3.06	1.23	2.11	0.26**	0.57**	-0.45**	0.13**	44.03	42.35	43.42	43.27	0.43	-0.14	0.10	0.13
LMH62xLCK 88062	1.31	3.36	1.57	2.08	-0.53**	0.87**	-0.37**	-0.01	43.90	41.56	42.77	42.74	0.53	-0.04	-0.23	0.09
DPL - 21 x J 23	2.76	3.04	1.61	2.47	-0.22**	0.46**	-0.52**	-0.09*	42.90	41.75	40.33	41.66	036	0.26	-0.19	0.14
DPL - 21 x RLC - 6	2.08	1.40	1.26	1.58	-0.39**	-0.80**	-0.70**	-0.63**	43.47	43.00	41.63	42.70	-0.14	0.45*	-0.60**	-0.10
DPL - 21 x Garima	3.28	3.00	1.23	2.51	0.62**	0.53**	-0.61**	0.18**	43.58	41.76	41.53	42.29	0.77	-0.10	-0.27	0.13
DPL - 21 x KL - 43	3.58	3.27	2.83	3.23	0.26**	0.03	0.21**	0.17**	43.51	42.42	41.94	42.63	0.11	0.41	0.08	0.20
DPL-21xLCK 88062	3.61	3.03	4.12	3.59	0.24**	-0.21**	1.24**	0.43**	42.88	40.84	41.83	41.86	-0.29	-0.23	0.27	-0.08
J - 23 x RLC - 6	1.01	1.62	1.40	1.34	-0.49**	0.19*	0.27**	-0.01	43.44	41.92	41.35	42.16	0.95*	-0.51*	-0.54**	-0.04
J - 23 x Garima	1.39	1.67	1.27	1.44	-0.31**	-0.03	0.26**	-0.03	41.78	41.65	42.14	41.86	0.30	-0.10	0.68**	0.29
J - 23 x KL - 43	2.08	2.99	1.57	2.21	-0.28**	0.51**	-0.21**	0.01	40.98	42.32	41.07	41.46	-1.09*	0.42	-0.46**	-0.38*
J - 23 x LCK 88062	2.92	1.84	1.63	2.13	0.51**	-0.63**	-0.41**	-0.18**	41.42	41.47	41.42	41.53	-0.43	0.46*	0.20	0.08
RLC 6 x Garima	1.32	1.59	1.12	1.34	0.14*	0.26**	0.27**	0.22**	41.83	43.19	43.19	42.73	-0.72	0.38	0.02	-0.11
RLC 6 x KL - 43	2.09	1.83	1.37	1.76	0.23**	-0.27**	-0.25**	-0.10**	43.53	43.06	43.55	43.38	0.38	0.10	0.32	0.26
RLC 6 x LCK 88062	1.55	1.65	1.45	1.55	-0.35**	-0.49**	-0.43**	-0.41**	42.77	42.00	42.75	42.51	-0.14	-0.06	-0.18	-0.13
Garima x KL - 43	1.69	2.78	1.16	1.88	-0.35**	0.42**	-0.34**	0.09*	41.41	42.41	42.65	42.16	-0.94*	0.13	-0.16	-0.32
GarimaxLCK 88062	1.97	1.88	1.18	1.68	-0.12*	-0.44**	-0.58**	-0.39**	43.01	42.45	42.60	42.69	0.89*	1.07**	0.10	0.69**
KL 43 x LCK 88062	3.02	3.06	2.75	2.94	0.27**	-0.08	0.21**	0.13**	43.02	41.13	42.65	42.27	0.31	-0.40	0.09	0.00
S.E. (m.diff.) ±	0.01	0.01	0.01	0.01					0.06	0.03	0.03	0.03				
S.E. (S_{ij}) ±					0.06	0.08	0.07	0.04					0.43	0.23	0.17	0.17
S.E. (S_{ij} - S_{ik}) ±					0.09	0.12	0.10	0.06					0.64	0.34	0.26	0.25

Table Contd.....

Cross Combination	13. Seed yield/plant (g)							
	Mean Value				SCA effects			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	5.73	4.81	6.06	5.53	0.89**	0.34*	-0.01	0.41**
Neelum x Sweta	3.58	5.61	5.28	4.82	-0.40**	0.09	-0.17	-0.16*
Neelum x LMH-62	6.46	5.98	6.19	6.21	-0.63**	-0.13	-0.34**	-0.37**
Neelum x DPL-21	4.44	4.87	4.52	4.61	0.00	-0.18	-0.52**	-0.23**
Neelum x J-23	6.00	5.07	6.08	5.72	0.03	0.34*	0.08	0.15
Neelum x RLC-6	6.37	4.80	6.17	5.78	0.45**	-0.26	0.77**	0.32**
Neelum x Garima	5.83	5.85	7.29	6.32	-0.66**	0.06	0.98**	0.13
Neelum x KL-43	4.92	4.89	5.18	5.00	-0.53**	0.13	-0.09	-0.16*
Neelum xLCK88062	6.70	5.57	6.60	6.29	0.49**	0.20	0.52**	0.40**
Shubhra x Sweta	3.23	5.65	5.15	4.68	0.01	0.67**	-0.70**	0.00
Shubhra x LMH-62	6.82	5.13	6.55	6.17	0.49**	-0.43**	-0.38**	-0.11
Shubhra x DPL-21	3.23	4.53	5.50	4.42	-0.45**	0.03	0.05	-0.12
Shubhra x J-23	4.72	3.87	7.59	5.39	-0.49**	-0.32*	1.19**	0.13
Shubhra x RLC-6	5.13	4.64	6.28	5.35	-0.02	0.13	0.47**	0.19*
Shubhra x Garima	6.03	5.90	6.93	6.28	0.30*	0.65**	0.22*	0.39**
Shubhra x KL-43	4.23	4.71	5.12	4.69	-0.46**	0.50**	-0.55**	-0.17*
ShubhraxLCK88062	5.08	3.90	6.45	5.14	-0.36**	-0.92**	-0.04	-0.44**
Sweta x LMH – 62	5.03	6.35	6.87	6.08	-0.45**	-0.27	0.56**	-0.05
Sweta x DPL – 21	3.16	5.72	5.26	4.71	0.33**	0.15	0.43**	0.31**
Sweta x J 23	3.66	5.86	6.09	5.21	-0.70**	0.62**	0.31**	0.08
Sweta x RLC – 6	4.56	5.78	4.92	5.09	0.26*	0.21	-0.27*	0.07
Sweta x Garima	5.83	6.18	5.47	5.83	0.96**	-0.12	-0.62**	0.07
Sweta x KL – 43	4.36	4.69	4.94	4.66	0.52**	-0.59**	-0.11	-0.06
Sweta x LCK 88062	3.93	6.10	7.13	5.72	-0.67**	0.22	1.27**	0.27**
LMH62 x DPL – 21	6.10	6.78	6.30	6.39	0.17	0.63**	0.39**	0.40**

Table Contd……

Cross Combination	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	6.93	5.85	6.50	6.43	-0.53**	0.02	-0.36**	-0.29**
LMH 62 x RLC - 6	7.90	6.27	6.27	6.81	0.49**	0.11	0.00	0.20*
LMH 62 x Garima	8.09	6.92	7.08	7.36	0.11	0.02	-0.09	0.01
LMH 62 x KL - 43	7.78	5.38	5.17	6.11	0.84**	-0.49**	-0.96**	-0.20*
LMH62xLCK 88062	7.73	6.62	7.00	7.11	0.03	0.15	0.06	0.08
DPL - 21 x J 23	5.63	4.54	5.86	5.34	0.81**	-0.24	0.49**	0.35**
DPL - 21 x RLC - 6	6.03	5.47	6.23	5.91	1.27**	0.37*	1.45**	1.03**
DPL - 21 x Garima	3.92	5.94	4.59	4.81	-1.42**	0.11	-1.10**	-0.80**
DPL - 21 x KL - 43	3.93	4.93	4.90	4.59	-0.36**	0.12	0.26*	0.01
DPL-21xLCK 88062	5.13	5.69	4.50	5.11	0.08	0.28	-0.96**	-0.20*
J - 23 x RLC - 6	6.73	5.02	5.82	5.86	0.44**	0.24	0.08	0.26**
J - 23 x Garima	6.93	5.89	7.24	6.69	0.07	0.38*	0.60**	0.35**
J - 23 x KL - 43	6.73	4.77	5.29	5.60	0.90**	0.29	-0.31**	0.29**
J - 23 x LCK 88062	7.09	5.67	5.79	6.18	0.51**	0.58**	-0.63**	0.15
RLC 6 x Garima	6.12	6.29	5.38	5.93	-0.70**	0.45**	-0.67**	-0.31**
RLC 6 x KL - 43	6.12	4.75	4.83	5.23	0.34**	-0.06	-0.19	0.03
RLC 6 x LCK 88062	6.66	5.86	5.55	6.02	0.13	0.44**	-0.27*	0.10
Garima x KL - 43	7.27	5.68	6.93	6.63	0.92**	0.14	1.02**	0.69**
GarimaxLCK 88062	7.40	5.95	6.58	6.64	0.30*	-0.20	-0.14	-0.01
KL 43 x LCK 88062	5.07	4.78	6.34	5.40	-1.00**	-0.34*	0.66**	-0.23**
S.E. (m.diff.) ±	0.02	0.02	0.02	0.01				
S.E. (S_{ij}) ±					0.13	0.16	0.11	0.08
S.E. (S_{ij} - S_{ik}) ±					0.19	0.23	0.16	0.11

*Significant at $p = 0.05$ ** Significant at $p = 0.01$ L_1: Rath; L_2: Jabalpur; L_3 : Kanpur

Table -10 : Estimates of heterosis in F_1 over superior parent (Percent), Mid parent (percent) and Inbreeding depression (percent) in F_2 derived from 10 parent diallel cross for 13 traits in linseed.

Days to 50% flowering

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	5.21**	7.10**	0.00	4.10**	4.39**	0.77	-1.99*	1.06	-1.98	-13.27**	-0.45	-5.23**
Neelum x Sweta	6.51**	16.46**	3.72**	8.90**	-1.10	3.24**	-4.88**	-0.91	-1.67	-20.94**	-12.82**	-11.81**
Neelum x LMH-62	13.66**	10.65**	8.00**	10.77**	2.81*	-0.27	-4.79**	-0.75	10.38**	-0.53	-15.87**	-2.01
Neelum x DPL-21	12.31**	-4.85**	0.90	2.79*	-2.45*	-6.22**	-5.29**	-4.90**	22.83**	10.71**	-7.14**	8.80**
Neelum x J-23	-0.62	10.31**	-1.84	2.62*	-9.80**	7.00**	-2.96**	-1.92	-31.68**	-17.29**	-4.69**	-17.89**
Neelum x RLC-6	2.05	11.05**	6.25**	6.45**	1.53	6.57**	2.79**	3.63**	2.51*	-2.84*	-1.81	-0.71
Neelum x Garima	7.83**	5.38**	2.96**	5.39**	-0.83	0.00	-1.65	-0.83	-6.15**	-6.12**	-4.78**	-5.68**
Neelum x KL-43	7.18**	7.94**	0.95	5.36**	3.47**	3.29**	-1.62	1.71	11.00**	0.49	-3.76*	2.58*
Neelum xLCK88062	0.00	2.70**	0.00	0.90	0.00	-2.81**	-1.55	-1.45	3.08**	-11.05**	-6.31**	-4.76**
Shubhra x Sweta	3.55**	5.49**	7.45**	5.50**	-3.05**	-0.29	-3.58**	-2.31*	-12.00**	-28.32**	-9.41**	-16.58**
Shubhra x LMH-62	37.89**	27.81**	2.29*	22.66**	25.78**	22.73**	-11.82**	12.23**	13.96**	9.72**	-5.03**	6.22**
Shubhra x DPL-21	-11.98**	1.09	0.43	-3.49**	-24.22**	-6.33**	-3.73**	-11.43**	-10.65**	-2.16	4.31**	-2.83*
Shubhra x J-23	17.28**	6.56**	3.23**	9.02**	7.34**	3.45**	0.00	3.60**	-3.16**	-14.87**	-8.93**	-8.99**
Shubhra x RLC-6	0.00	2.19*	3.37**	1.85	-1.29	0.27	-2.05*	-1.02	-11.46**	-13.90**	-6.51**	-10.62**
Shubhra x Garima	25.90**	1.09	5.42**	10.80**	16.76**	0.27	-1.38	5.22**	-0.96	-19.46**	1.40	-6.34**
Shubhra x KL-43	-4.17**	-1.09	2.84**	-0.81	-8.23**	-2.69**	-1.81	-4.24**	-6.52**	-15.47**	0.46	-7.18**
Shubhra x LCK88062	-15.10**	-4.92**	-0.87	-6.96**	-15.76**	-5.43**	-1.30	-7.50**	-25.15**	-22.41**	-3.52*	-17.03**
Sweta x LMH – 62	18.63**	12.20**	-4.00**	8.94**	15.76**	10.51**	-7.44**	6.28**	9.42**	2.72*	-13.69**	-0.52
Sweta x DPL – 21	-1.18	17.07**	6.91**	7.60**	-21.04**	2.13**	-8.43**	-9.11**	-29.34**	-20.83**	-23.88**	-24.68**
Sweta x J 23	3.09*	10.37**	3.72**	5.73**	0.91	1.12	-3.70**	-0.56	-10.78**	-23.76**	-17.95**	-17.50**
Sweta x RLC – 6	7.69**	16.46**	3.72**	9.29**	-0.55	7.91**	-1.52	1.95*	-7.14**	-12.57**	-6.67**	-8.79**
Sweta x Garima	28.31**	31.10**	-1.06	19.45**	27.16**	22.86**	-4.86**	15.05**	12.21**	0.47	-16.67**	-1.33
Sweta x KL – 43	14.20**	20.12**	1.60	11.97**	2.12	11.61**	-4.26**	3.16**	4.15**	-10.15**	-10.99**	-5.66**
Sweta x LCK 88062	-17.95**	7.32**	6.91**	-1.24	-12.09**	0.86	-3.60**	-4.94**	-13.12**	-28.98**	-15.42**	-19.17**
LMH62 x DPL – 21	32.92**	23.67**	-1.14	18.48**	3.13**	9.71**	-18.78**	-1.98*	14.02**	6.70**	-45.66**	-8.31**

Table : Contd....

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	39.75**	24.26**	1.71	21.91**	39.32**	15.70**	-9.18**	15.28**	14.67**	11.43**	-21.91**	1.40
LMH 62 x RLC – 6	41.61**	17.16**	0.00	19.59**	27.37**	10.31**	-8.62**	9.69**	20.61**	3.54**	-21.14**	1.03
LMH 62 x Garima	59.01**	26.04**	0.57	28.54**	56.57**	20.00**	-6.88**	23.23**	25.39**	5.63**	-6.82**	8.07**
LMH 62 x KL – 43	41.61**	14.79**	2.86**	19.75**	23.24**	8.38**	-6.74**	8.29**	5.70**	10.82**	-10.56**	1.99
LMH62x LCK 88062	17.39**	14.20**	6.29**	12.63**	6.18**	9.04**	-7.92**	2.43*	-4.23**	7.77**	-25.27**	-7.24**
DPL – 21 x J 23	32.10**	-4.12**	1.84	9.94**	2.88*	-8.37**	-5.56**	-3.68**	2.34*	-18.82**	-14.48**	-10.32**
DPL – 21 x RLC - 6	-1.52	2.11*	11.06**	3.88**	-13.97**	-3.48**	0.65	-5.60**	-8.25**	-19.07**	9.52**	-5.93**
DPL – 21 x Garima	24.70**	4.30**	3.94**	10.98**	-1.43	-2.51**	-7.05**	-3.66**	4.35**	-8.76**	-19.91**	-8.11**
DPL – 21 x KL - 43	-22.01**	0.00	8.53**	-4.49**	-29.59**	-5.74**	-0.87	-12.07**	-30.67**	-21.16**	6.11**	-15.24**
DPL-21xLCK 88062	6.67**	3.78**	-3.49**	2.32*	-7.35**	-3.27**	-7.92**	-6.18**	6.73**	-15.10**	-14.93**	-7.77**
J - 23 x RLC - 6	21.60**	4.21**	14.90**	13.57**	9.75**	3.12**	12.47**	8.45**	5.58**	-9.09**	-7.53**	-3.68**
J - 23 x Garima	8.02**	2.15*	-0.99	3.06**	6.71**	0.00	-4.29**	0.81	-10.86**	-10.53**	-8.96**	-10.12**
J - 23 x KL - 43	23.46**	1.06	0.47	8.33**	7.82**	-0.26	-0.93	2.21*	3.00**	-10.99**	2.36	-1.88
J - 23 x LCK 88062	22.84**	6.49**	1.84	10.39**	11.48**	3.96**	-0.90	4.85**	5.03**	-7.61**	-4.98**	-2.52
RLC 6 x Garima	33.73**	0.54	3.94**	12.74**	22.31**	-0.53	2.68**	8.15**	10.81**	-20.32**	1.42	-2.70*
RLC 6 x KL - 43	-4.57**	-1.59	3.85**	-0.77	-7.39**	-1.85*	3.10**	-2.05*	-1.06	-17.74**	3.24*	-5.19**
RLC 6 x LCK 88062	-11.79**	-8.65**	0.96	-6.49**	-12.24**	-9.87**	-3.89**	-8.67**	-11.05**	-30.77**	-7.14**	-16.32**
Garima x KL - 43	11.45**	-2.15*	4.43**	4.58**	-1.33	-2.93**	2.42*	-0.61	-1.08	-18.68**	3.30*	-5.49**
Garima x LCK 88062	-1.81	1.08	4.43**	1.23	-9.70**	0.81	-1.85	-3.58**	-14.11**	-25.67**	-8.96**	-16.25**
KL 43 x LCK 88062	-5.64**	4.86**	4.27**	1.16	-8.91**	3.74**	0.00	-1.72	1.09	-11.86**	3.18*	-2.53
S.E. ±	1.38	0.99	1.09	1.15	1.14	0.82	1.01	0.99	1.03	1.29	1.60	1.31

2. Days to maturity

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	0.77	1.36	1.01	1.05	0.38	-0.27	-1.23	-0.37	3.32	-11.29**	-4.50**	-4.16
Neelum x Sweta	1.02	0.80	2.36*	1.39	0.38	0.13	-1.76	-0.42	7.32*	-5.04	-8.18**	-1.97
Neelum x LMH-62	4.12**	3.93	7.98**	5.34**	0.26	0.68	2.78**	0.27	1.32	-3.24	-6.40**	-2.77
Neelum x DPL-21	6.38**	-0.53	3.86**	3.24	2.58**	-1.31	2.38*	1.22	14.63**	0.27	-3.72**	3.73
Neelum x J-23	8.65**	1.88	4.44**	4.99*	5.51**	0.93	3.30**	3.25	4.23	-12.40**	-2.13	-3.43
Neelum x RLC-6	1.28	3.06	4.24**	2.86	1.02	0.41	-0.63	0.27	5.82	-9.16*	-6.87**	-3.40
Neelum x Garima	2.56*	0.00	1.77	1.44	2.43*	-0.80	-0.62	0.34	10.22**	-1.07	-7.21**	0.65
Neelum x KL-43	2.30*	1.85	9.69**	4.61*	1.39	-0.52	9.55**	3.47	6.98	-2.33	5.30**	3.32
Neelum x LCK88062	3.57**	1.06	3.53**	2.72	1.88	0.66	1.36	1.30	2.22	-8.6 8*	-6.57**	-4.34
Shubhra x Sweta	-4.63**	0.82	2.36*	0.48	-5.60**	-0.13	0.51	-1.74	-0.27	-8.11*	-1.79	-3.39
Shubhra x LMH-62	11.54**	8.71*	3.46**	7.90**	7.84**	7.05	0.78	5.22**	7.14	-1.03	-2.31	1.27
Shubhra x DPL-21	-1.03	2.18	3.03**	1.39	-4.94**	-0.27	-0.73	-1.98	3.90	-8.27*	-5.88**	-3.42
Shubhra x J-23	6.76**	0.54	0.25	2.52	4.08**	-0.14	-0.87	1.02	4.56	-16.53**	-4.28**	-5.42
Shubhra x RLC-6	1.29	4.17	1.59	2.35	1.16	3.16	-0.91	1.14	3.81	-12.80**	-4.18**	-4.39
Shubhra x Garima	3.34**	5.99	0.51	3.28	3.08**	5.14	0.38	2.87	7.71*	-1.03	-1.26	1.81
Shubhra x KL-43	3.86**	4.90	11.36**	6.71**	2.54**	0.79	9.02**	4.12*	7.67*	-4.42	4.08**	-2.45
Shubhra x LCK88062	-0.26	0.00	6.82**	2.19	-2.27*	-1.21	6.68**	1.07	0.52	-23.43**	4.49**	-6.14*
Sweta x LMH – 62	8.52**	3.93	3.46**	5.30**	3.81**	1.37	2.64*	2.61	6.33	-5.14	1.29	0.83
Sweta x DPL – 21	0.25	1.34	3.93**	1.84	-2.69**	-0.13	-1.73	-1.52	2.76	-7.65*	-7.81**	-4.23
Sweta x J 23	9.46**	4.84	7.85**	7.38**	5.61**	4.56	4.70**	4.96**	7.41*	-1.79	4.13**	3.25
Sweta x RLC – 6	6.41**	5.28	2.65*	4.78*	5.46**	3.27	1.98	3.57	11.08**	-1.06	-1.29	2.91
Sweta x Garima	-1.28	1.61	2.88*	1.07	-2.03*	1.47	1.16	0.20	2.85	-4.75	-3.31*	-1.74
Sweta x KL – 43	-4.53**	-1.07	3.66**	-0.65	-4.77**	-4.02	-0.38	-3.06	-2.64	-19.19**	-10.10**	-10.64**
Sweta x LCK 88062	-2.27*	-3.48	4.19**	-0.52	-3.24**	-3.73	2.18*	-1.60	0.77	-17.17**	-6.53**	-7.64**
LMH62 x DPL – 21	9.62**	8.15*	7.18**	8.32**	1.66	3.91	0.50	2.02	7.27*	-0.52	-13.40**	-2.22

Table : Contd....

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	11.26**	5.96	4.26**	7.14**	10.35**	3.57	0.38	4.77*	6.42	-4.24	-7.91**	-1.91
LMH 62 x RLC – 6	11.54**	10.39**	1.86	7.93**	7.69**	9.78**	1.73	6.40**	3.94	-0.76	-2.35	0.83
LMH 62 x Garima	16.48**	9.83**	3.99**	10.10**	12.32**	7.27*	1.43	7.01**	10.61**	-1.79	-5.37**	1.15
LMH 62 x KL – 43	16.21**	12.92**	4.26**	11.13**	10.88**	6.77	-0.63	5.67**	10.40**	-0.25	-10.46**	-0.10
LMH62 x LCK 88062	6.32**	4.49	1.86	4.22*	0.65	1.64	-0.91	0.46	4.39	-5.38	-6.53**	-2.51
DPL - 21 x J 23	6.49**	1.34	0.99	2.94	-0.38	-0.40	-1.56	-0.78	2.28	-8.49*	-4.89**	-3.71
DPL - 21 x RLC - 6	2.31*	4.17	4.24**	3.57	-1.60	0.67	-2.12*	-1.02	5.51	-4.80	-8.91**	-2.73
DPL - 21 x Garima	0.77	4.29	2.78*	2.61	-2.96**	2.64	-1.10	-0.47	0.25	-4.37	-7.64**	-3.92
DPL - 21 x KL - 43	-0.25	-1.56	4.84**	1.01	-2.93**	-3.07	3.22**	-0.93	1.76	-14.25**	-7.16**	-6.55*
DPL-21xLCK 88062	0.49	6.12	2.52*	3.04	-1.45	4.86	-1.09	0.77	1.23	-2.01	-7.86**	-2.88
J - 23 x RLC - 6	8.11**	6.39	3.98**	6.16**	5.26**	4.64	0.26	3.39	5.75	-1.04	-6.89**	-0.73
J - 23 x Garima	11.89**	4.03	2.78*	6.23**	8.80**	3.89	1.50	4.73*	9.42*	0.00	-3.94**	1.83
J - 23 x KL - 43	11.35**	13.17**	2.72*	9.08**	7.15**	9.49**	1.71	6.12**	5.58	4.28	-4.33**	1.84
J - 23 x LCK 88062	16.22**	9.14*	1.51	8.96**	10.97**	8.56*	0.50	6.68**	11.86**	-0.25	-4.47**	2.38
RLC 6 x Garima	8.46**	16.67**	2.12	9.08**	8.32**	14.60**	-0.26	7.55**	9.46*	0.00	-3.38**	2.03
RLC 6 x KL - 43	11.28**	10.28**	2.65*	8.07**	10.01**	4.89	-2.03	4.29*	10.83**	-8.56*	-8.27**	-2.00
RLC 6 x LCK 88062	4.87**	6.39	2.65*	4.64*	2.89**	4.08	0.00	2.32	-2.93	-12.01**	-3.10**	-6.01*
Garima x KL - 43	0.77	2.41	2.03	1.74	-0.25	-0.78	-0.25	-0.43	-6.60	-10.73**	-6.20**	-7.84**
Garima x LCK 88062	2.56*	0.00	3.04**	1.87	0.75	-0.40	2.78**	1.04	1.00	-8.31*	-3.93**	-3.75
KL 43 x LCK 88062	0.75	2.39	5.79**	2.98	0.00	-0.39	3.70**	1.10	4.98	-9.87**	-4.52**	-3.14
S.E.) ±	1.14	3.68	1.17	2.00	0.97	3.65	1.07	1.90	3.68	3.73	1.29	2.90

3. Plant height (cm.)

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
NeelumxShubhra	18.00**	18.96**	32.80**	25.05**	9.40*	8.30	16.66**	11.45*	6.22	4.12	13.48**	7.94
Neelum x Sweta	33.53**	8.96	10.30*	17.60**	16.89**	4.51	-0.57	6.94	23.12**	30.69**	7.41	20.41**
Neelumx LMH-62	57.94**	99.07**	8.17	55.05**	21.57**	33.47**	-4.49	16.85**	10.82*	22.11**	-8.75	8.06
Neelum x DPL-21	3.47	8.36	25.33**	12.39*	2.14	4.66	19.88**	8.90	53.39**	25.57**	17.05**	32.00**
Neelum x J-23	13.63**	8.11	17.98**	13.24*	6.48	2.51	9.97*	6.32	10.84**	-6.66	10.60*	4.93
Neelum x RLC-6	68.24**	9.46	7.45	28.38**	27.06**	-2.83	3.98	9.40*	15.53**	4.78	5.58	8.63
Neelumx Garima	27.37**	15.40*	22.78**	21.85**	12.86**	5.51	6.83	8.40	24.69**	8.06	10.05*	14.27**
Neelum x KL-43	15.60**	8.34	29.17**	17.70**	7.93*	5.03	26.24**	13.07**	20.44**	32.26**	15.67**	22.79**
NeelumxLCK88062	7.72**	16.08*	14.33**	12.71*	5.42	7.94	12.71**	8.51	1.51	9.70*	7.66	6.29
Shubhra x Sweta	18.65**	-2.72	2.96	6.30	12.45**	-7.48	-3.03	0.65	-2.93	-18.32**	-17.42**	-12.89**
Shubhra x LMH-62	65.43**	89.04**	16.68**	57.05**	38.95**	42.31**	12.07**	31.13**	7.23	9.53*	3.91	6.89
Shubhra x DPL-21	17.91**	14.03*	15.70**	15.88**	7.81*	7.69	-7.21	2.77	5.78	14.48**	-31.48**	-3.74
Shubhra x J-23	5.54	0.37	23.09**	9.67	4.48	-3.45	12.15**	4.40	-6.12	-42.42**	13.75**	11.60*
Shubhra x RLC-6	50.27**	4.01	31.83**	28.70**	23.97*	1.62	15.45**	13.68**	-2.24	-18.23**	15.33**	-1.71
Shubhra x Garima	16.54**	14.59*	12.06*	14.40**	11.72**	14.15**	9.09	11.63*	9.90	-0.26	3.84	4.49
Shubhra x KL-43	7.82*	'9.60	38.53**	18.65**	7.11	-3.53	20.01**	7.86	0.26	1.61	23.88**	8.58
Shubhra x LCK88062	-1.82	0.96	43.38**	14.17**	-6.89	-1.02	23.05**	5.04	-22.11**	-39.46**	24.15**	-12.47*
Sweta x LMH – 62	42.06**	90.90**	12.01*	48.32**	26.61**	35.04**	9.92*	23.86**	12.54*	15.65**	8.79	12.32*
Sweta x DPL – 21	14.75**	3.82	42.79**	20.45**	-1.01	3.12	22.60**	8.20	-2.08	15.83**	21.16**	11.64*
Sweta x J 23	23.89**	15.40*	12.43**	17.24**	16.17**	14.14**	8.96	13.09**	5.51	17.66**	-3.01	6.72
Sweta x RLC – 6	65.82**	18.96**	20.25**	35.05**	45.28**	10.41	12.25**	22.65**	20.29**	3.35	13.48**	12.37*
Sweta x Garima	33.85**	13.11	21.41**	22.79**	32.39**	8.01	17.56**	19.32**	23.82**	18.12**	9.99	17.31**
Sweta x KL – 43	18.24**	-0.66	26.38**	14.65**	11.28**	-7.74	16.77**	6.77	0.51	-5.31	15.05**	3.42
Sweta x LCK 88062	-5.05	-11.48	24.89**	2.79	-14.89**	-14.08**	14.33**	-4.88	-18.51**	-29.74**	15.89**	-10.79*
LMH62 x DPL – 21	65.66**	88.00**	51.36**	68.34**	25.50**	31.83**	27.19**	28.17**	11.18*	0.82	26.88**	12.96**

Table : Contd….

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	63.77**	73.93**	20.23**	52.64**	35.96**	24.78**	14.28**	25.00**	10.71*	-1.58	14.47**	7.87
LMH 62 x RLC – 6	70.42**	87.87**	24.16**	60.82**	67.80**	45.51**	13.59**	42.30**	3.77	-4.31	16.65**	5.37
LMH 62 x Garima	66.91**	86.65**	11.51*	55.02**	46.97**	39.83**	10.06*	32.29**	13.07*	-3.75	5.63	4.98
LMH 62 x KL – 43	66.69**	87.83**	24.61**	59.71**	38.94**	20.87**	12.82**	24.21**	12.66*	-20.37**	15.10**	2.46
LMH62 x LCK 88062	45.26**	83.88**	26.80**	51.98**	14.76**	35.06**	13.74**	21.18**	3.67	2.33	16.51**	7.50
DPL - 21 x J 23	-3.73	5.71	39.73**	16.39**	-4.12	3.85	24.22**	7.98	0.86	-21.95**	25.25**	1.39
DPL - 21 x RLC - 6	34.30**	9.72	24.69**	22.97**	-0.20	1.29	15.26**	5.45	-2.94	-27.00**	18.93**	-3.67
DPL - 21 x Garima	16.63**	-5.83	19.00**	9.93	1.86	-10.71*	-1.52	3.46	2.34	-10.13*	13.74**	1.98
DPL - 21 x KL - 43	13.52**	-2.46	30.89**	13.98**	4.53	-8.76	22.24**	6.00	9.44	-30.85**	9.43	-4.00
DPL-21xLCK 88062	5.19	10.51	53.57**	23.09**	1.59	6.52	44.72**	17.61**	10.12	-48.16**	27.12**	-3.64
J - 23 x RLC - 6	42.13**	15.85*	11.70*	23.23**	15.88**	8.78	7.71	10.79*	-5.69	-10.30*	7.19	-2.93
J - 23 x Garima	7.28	8.06	14.86**	10.07	1.77	4.37	7.67	4.58	1.71	-7.85	11.12*	1.68
J - 23 x KL - 43	-2.12	14.97*	11.39*	9.49	1.77	5.52	6.34	4.54	15.20**	9.19*	4.86	9.75
J - 23 x LCK 88062	10.42**	6.88	21.67**	12.99*	5.83	4.91	15.12**	8.62	10.51*	-1.74	14.65**	7.81
RLC 6 x Garima	43.13**	11.84	26.06**	27.01**	23.87**	8.83	13.70**	15.47**	-1.79	-1.56	17.81**	4.82
RLC 6 x KL - 43	58.81**	12.50	14.13**	28.48**	30.00**	-3.52	13.03**	13.17**	9.69	9.72*	7.46	8.96
RLC 6 x LCK 88062	15.79**	-0.07	9.84*	8.52	-10.21**	-4.32	7.85	-2.23	-41.10**	-24.40**	6.93	-9.52**
Garima x KL - 43	-13.98**	-1.58	28.27**	4.24	-18.10**	-13.00*	14.48**	-5.54	-24.72**	11.44*	13.68**	0.13
Garima x LCK 88062	-13.93**	-13.20	28.75**	0.54	-21.92**	-14.56**	13.82**	-7.53	-25.39**	-3.56	15.78**	-4.39
KL 43 x LCK 88062	-41.00**	1.10	16.14**	-7.92	-43.65**	-9.06	15.15**	-12.52**	-53.40**	11.82*	12.00*	-9.86*
S.E. ±	3.92	7.09	4.78	5.26	3.83	5.44	4.68	4.65	5.20	4.67	5.12	5.00

Table Contd….

4. Tech. Plant height (cm.)

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	4.57	4.19	1.98	3.58	7.95*	17.48**	18.70**	14.71**	7.17**	1.93	22.01**	10.37**
Neelum x Sweta	13.92**	5.22*	-6.00*	4.38	32.91**	13.86**	6.74**	17.84**	34.07**	30.25**	12.94**	25.75**
Neelum x LMH-62	1.59	12.02**	-20.83**	-18.99**	16.84**	12.04**	-7.91**	6.99**	18.94**	30.59**	-30.19**	6.45*
Neelum x DPL-21	8.91	20.61**	-70.57**	13.68**	23.84**	22.01**	-66.59**	6.91**	32.33**	39.06**	-174.92**	-34.27**
Neelum x J-23	12.56*	14.01**	4.84*	10.47**	38.06**	19.04**	19.06**	25.39**	15.74**	-17.68**	16.79**	4.95
Neelum x RLC-6	10.90*	1.77	4.39	5.69	30.34**	10.25**	20.46**	20.35**	19.86**	23.57**	21.48**	21.69**
Neelum x Garima	12.50*	14.08**	11.22**	12.6**	18.05**	17.02**	21.41**	18.83**	26.99**	34.33**	16.01**	25.78**
Neelum x KL-43	0.43	42.31**	17.00**	19.91**	2.99	51.31**	19.53**	24.54**	8.20**	47.36**	7.76	21.11**
Neelum xLCK88062	10.81**	33.74**	7.37**	17.31**	20.32**	35.93**	12.60**	22.92**	16.29**	29.19**	8.73*	18.04**
Shubhra x Sweta	-0.42	29.50**	-3.81	8.42**	13.03**	35.46**	-1.01	15.83**	-8.36**	5.14	-11.76**	-5.00
Shubhra x LMH-62	50.04**	26.31**	12.26**	29.54**	67.79**	42.45**	12.34**	40.93**	27.37**	23.99**	6.92	19.43**
Shubhra x DPL-21	-24.98**	4.12	-24.65**	-15.17**	-12.33**	16.21**	-2.58	0.43	-10.04**	20.48**	-37.03**	-8.86**
Shubhra x J-23	5.03	11.14**	5.55*	7.24*	25.58**	20.47**	8.62**	18.22**	-18.93**	61.20**	5.32	15.86**
Shubhra x RLC-6	4.18	30.27**	4.87*	13.11**	19.16**	36.10**	5.94**	20.04**	-13.34**	2.82	3.77	-2.25
Shubhra x Garima	6.20	18.66**	12.11**	12.32**	8.00*	30.78**	20.35**	19.71**	0.76	5.36	18.57**	8.23*
Shubhra x KL-43	35.89**	8.10**	13.16**	19.05**	36.82**	28.56**	29.32**	31.57**	14.24**	7.38*	25.56**	15.73**
Shubhra x LCK88062	-35.28**	1.60	8.05**	-8.54**	-27.65**	16.20**	30.85**	6.47*	-103.97**	13.87**	28.74**	-20.45**
Sweta x LMH – 62	1.31	-4.74*	7.11**	1.23	3.03	3.10	10.14**	5.42*	-42.44**	13.42**	6.30	-7.57*
Sweta x DPL – 21	-21.63**	-12.33**	13.00**	-6.99*	1.64	-6.15**	43.05**	12.85**	-18.78**	-18.03**	41.31**	1.5
Sweta x J 23	52.13**	12.34**	12.42**	25.63**	61.58**	16.63**	12.42**	30.21**	9.12**	20.18**	7.56	12.29**
Sweta x RLC – 6	96.87**	34.61**	10.24**	47.24**	98.61**	34.77**	12.32**	48.57**	29.75**	31.20**	5.62	22.19**
Sweta x Garima	64.40**	62.08**	12.32**	46.27**	83.86**	71.23**	17.33**	57.47**	28.16**	38.07**	7.63	24.62**
Sweta x KL – 43	4.38	-5.74*	8.85**	2.50	19.18**	7.89**	21.29**	16.12**	-10.30**	-3.50	10.13*	-1.22
Sweta x LCK 88062	-29.30**	6.53**	5.60*	5.72	-11.70**	17.01**	24.93**	17.88**	-41.83**	-10.57**	12.82**	-13.19**
LMH62 x DPL – 21	13.58**	15.76**	8.36**	12.57**	45.54**	17.13**	40.01**	34.23**	38.19**	25.95**	33.81**	32.65**

Table : Contd….

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	87.25**	10.81**	7.68**	35.25**	102.06**	15.72**	10.73**	42.84**	39.91**	13.84**	8.76*	20.84**
LMH 62 x RLC – 6	100.54**	32.13**	8.15**	46.84**	105.73**	43.17**	9.18**	52.69**	32.62**	19.42**	4.75	18.93**
LMH 62 x Garima	50.33**	47.00**	11.84**	36.39**	65.60**	50.81**	19.98**	45.46**	18.62**	19.11**	13.97**	17.23**
LMH 62 x KL – 43	60.49**	-0.08	13.49**	24.39**	80.57**	6.23**	29.63**	30.81**	2.02	-28.18**	11.59**	-4.86
LMH62 x LCK 88062	-16.04**	1.91	20.69**	2.12	3.51	3.56	46.07**	17.71**	-4.15*	20.46**	21.84**	12.72**
DPL – 21 x J 23	-10.23**	30.58**	15.70**	12.02**	21.43**	34.82**	46.47**	34.24**	4.98*	-21.67**	32.79**	5.37
DPL – 21 x RLC - 6	3.61	21.25**	9.92**	11.59**	35.21**	29.95**	41.06**	35.41**	21.18**	-24.49**	34.26**	10.32**
DPL – 21 x Garima	-17.55**	33.79**	15.26**	10.50**	-2.28	35.68**	41.09**	24.83**	-18.09**	-18.30**	35.68**	-0.24
DPL – 21 x KL - 43	0.01	14.03**	27.96**	14.00**	16.22**	22.57**	47.98**	28.92**	-8.31**	-32.64**	23.72**	-5.74
DPL-21xLCK 88062	1.76	30.07**	24.14**	18.66**	7.05*	33.71**	34.97**	25.24**	17.90**	-23.92**	46.61**	13.53**
J - 23 x RLC - 6	33.00**	2.42	6.99**	14.14**	40.10**	6.45**	9.00**	18.52**	-32.69**	-22.40**	4.18	-16.99**
J - 23 x Garima	4.31	10.72**	9.96**	8.32**	23.01**	12.75**	14.82**	16.86**	-21.67**	-21.61**	11.86**	-10.47**
J - 23 x KL - 43	1.33	26.71**	14.75**	14.26**	21.81**	40.27**	27.87**	29.98**	-31.78**	19.67**	11.30**	-0.29
J - 23 x LCK 88062	3.22	13.33**	12.75**	9.77**	34.84**	20.18**	32.67**	29.23**	-2.49	-17.06**	9.11*	-3.48
RLC 6 x Garima	4.17	19.30**	10.50**	11.32**	17.41**	26.18**	17.49**	20.36**	3.56	26.08**	16.51**	15.38**
RLC 6 x KL - 43	9.57*	-11.56**	17.29**	5.10	26.05**	1.33	32.87**	20.08**	1.96	4.91	23.26**	10.04**
RLC 6 x LCK 88062	-36.68**	-14.44**	13.54**	-12.53**	-20.39**	-5.93**	36.37**	3.35	-85.64**	-24.74**	17.83**	-30.85**
Garima x KL - 43	-0.08	-13.04**	18.06**	1.65	2.30	-5.31*	26.34**	7.78**	-15.84**	16.49**	18.74**	6.46*
Garima x LCK 88062	-36.59**	0.66	21.70**	4.74	-28.06**	4.90*	38.70**	5.18	-29.37**	16.61**	23.76**	3.67
KL 43 x LCK 88062	-21.72**	-15.00**	29.62**	-2.37	-13.02**	-11.01**	38.72**	4.90	-3.06	20.79**	19.33**	12.35**
S.E. ±	4.88	2.25	2.38	3.17	3.52	2.18	2.28	2.66	2.04	3.52	4.04	3.20

Table Contd:
5. No. of tillers/plant

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	16.05**	0.13	4.73**	6.97**	23.98**	10.67**	19.16**	18.20**	38.23**	16.98**	16.38**	23.86**
Neelum x Sweta	16.03**	-21.79**	17.30**	3.85**	26.67**	-9.18**	28.24**	15.24**	27.20**	-26.59**	18.99**	6.53**
Neelum x LMH-62	39.85**	0.81	38.47**	26.38**	40.46**	6.24**	39.18**	28.63**	19.33**	15.53**	17.86**	17.57**
Neelum x DPL-21	1.12**	-22.46**	20.29**	-0.35	26.34**	-1.66	42.95**	22.54**	56.16**	24.38**	31.63**	37.59**
Neelum x J-23	2.67**	10.71**	17.33**	10.24**	11.59**	17.22**	27.26**	18.69**	-38.77**	-35.75**	10.00**	-21.51**
Neelum x RLC-6	-10.00**	5.52**	36.33**	10.62**	-6.93**	6.28**	37.31**	12.22**	18.81**	-13.64**	20.86**	8.68**
Neelum x Garima	0.57	19.75**	23.45**	14.59**	8.73**	35.45**	29.03**	24.40**	29.52**	35.07**	14.49**	26.36**
Neelum x KL-43	44.31**	-19.44**	35.89**	20.25**	67.18**	-4.39**	49.68**	37.49**	46.14**	4.41**	20.91**	23.82**
Neelum x LCK88062	6.08**	10.88**	39.60**	18.85**	32.60**	40.52**	41.61**	38.24**	32.13**	34.38**	15.56**	27.36**
Shubhra x Sweta	22.41**	-10.54**	22.49**	11.43**	25.29**	-5.45**	51.09**	23.64**	30.90**	-15.91**	19.57**	11.52**
Shubhra x LMH-62	64.94**	18.78**	4.14**	29.29**	75.50**	37.57**	19.61**	44.23**	52.94**	17.91**	18.01**	29.62**
Shubhra x DPL-21	-41.45**	-34.25**	33.62**	-14.03**	-30.66**	-23.22**	39.77**	-4.70**	14.98**	-24.77**	28.15**	6.12**
Shubhra x J-23	-6.80**	6.37**	15.74**	5.10**	7.58**	23.71**	22.63**	17.97**	-3.37*	-37.59**	8.23**	-10.91**
Shubhra x RLC-6	-27.67**	22.78**	10.00**	-13.48**	-20.28**	34.82**	26.55**	13.70**	-9.73**	5.88**	23.67**	6.61**
Shubhra x Garima	4.42**	20.25**	5.56**	10.08**	5.77**	23.40**	15.99**	15.05**	28.38**	10.57**	-40.47**	-0.51
Shubhra x KL-43	11.96**	4.44**	9.05**	8.48**	22.17**	13.15**	13.70**	16.34**	16.87**	8.99**	2.88**	9.58**
Shubhra x LCK88062	-44.68**	-31.60**	21.48**	-18.27**	-34.45**	-20.19**	37.19**	-5.82**	-4.84**	-44.55**	17.00**	-10.80
Sweta x LMH – 62	13.64**	-11.13**	17.00**	6.50**	23.58**	7.82**	27.31**	19.57**	25.48**	-16.02**	10.03**	6.50**
Sweta x DPL – 21	-2.76**	-14.37**	33.57**	5.48**	12.93**	-4.79**	70.51**	26.22**	25.49**	-35.30**	29.90**	6.70**
Sweta x J 23	53.47**	-8.61**	-25.53**	6.44**	80.67**	11.31**	-12.39**	26.53**	49.22**	-25.38**	-31.69**	-2.62**
Sweta x RLC – 6	64.84**	-3.93**	13.70**	24.87**	85.52**	10.89**	23.50**	39.97**	45.49**	-13.35**	11.56**	14.57**
Sweta x Garima	-5.60**	-4.98**	17.75**	2.39**	-4.60**	-2.05	33.99**	9.11**	-9.87**	-9.99**	26.65**	2.26*
Sweta x KL – 43	-31.19**	-24.17**	30.80**	-8.19**	-26.53**	-22.16**	56.03**	2.45**	-35.82**	-35.02**	27.04**	-14.60**
Sweta x LCK 88062	-19.96**	-33.43**	21.80**	-10.53**	-7.00**	-26.04**	34.89**	0.62	6.05**	-44.58**	23.88**	-4.88**
LMH62 x DPL – 21	4.97**	-21.39**	16.08**	-0.11	30.72**	3.58*	38.51**	24.27**	42.12**	15.54**	27.62**	28.43**

Table : Contd….

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	58.29**	54.47**	13.33**	42.03**	72.74**	55.24**	23.50**	50.49**	23.59**	4.56**	14.94**	14.36**
LMH 62 x RLC – 6	96.36**	97.12**	12.66**	68.71**	103.91**	109.16**	12.44**	75.17**	47.49**	17.68**	6.76**	23.98**
LMH 62 x Garima	38.92**	31.71**	11.40**	27.34**	49.60**	55.90**	17.01**	40.84**	33.12**	24.93**	10.75**	22.93**
LMH 62 x KL – 43	47.31**	30.56**	28.35**	35.41**	70.07**	61.68**	42.03**	57.92**	46.68**	8.47**	15.81**	23.65**
LMH62 x LCK 88062	-7.92**	-28.18**	36.99**	0.30	14.73**	-5.43**	39.67**	16.32**	40.70**	-10.97**	20.00**	16.58**
DPL - 21 x J 23	-27.63**	-28.40**	25.63**	-10.13**	-3.81**	-5.35**	38.86**	9.90**	7.03**	-52.16**	25.13**	-6.67**
DPL - 21 x RLC - 6	-14.34**	-18.81**	5.67**	-9.16**	9.75**	2.42	26.28**	12.82**	20.06**	-12.85**	29.88**	12.36**
DPL - 21 x Garima	-8.73**	-11.09**	12.57**	-2.42	6.95**	1.55	28.81**	12.44**	-8.21**	-9.79**	28.62**	3.54**
DPL - 21 x KL - 43	-17.42**	-36.83**	27.42**	-8.94**	-9.60**	-31.42**	38.68**	-0.78	-2.52	-74.89**	16.09**	-20.44**
DPL-21xLCK 88062	-0.36	-12.03**	9.01**	-1.13	-0.30	-11.94**	28.01**	5.26**	5.66**	-7.45**	16.47**	4.90**
J - 23 x RLC - 6	-20.06**	1.68	5.80**	-4.19**	-15.82**	8.39**	15.50**	2.69**	-36.61**	-46.62**	14.87**	-22.79**
J - 23 x Garima	-4.53**	-9.72**	6.13**	-2.71**	11.40**	7.29**	10.33**	9.67**	-2.97*	-18.01**	7.60**	-4.46**
J - 23 x KL - 43	27.12**	-25.83**	20.23**	7.17**	57.89**	-7.80**	22.28**	24.12**	27.62**	-34.31**	20.10**	4.47**
J - 23 x LCK 88062	-12.60**	-26.63**	27.87**	-3.79**	16.22**	-3.07*	36.85**	16.67**	38.22**	-12.46**	16.94**	14.23**
RLC 6 x Garima	1.98**	15.58**	14.72**	10.76**	13.71**	29.90**	20.73**	21.45**	29.33**	26.36**	9.50**	21.73**
RLC 6 x KL - 43	-0.24	-7.50**	20.17**	4.14**	18.87**	9.14**	33.21**	20.41**	29.66**	12.13**	22.95**	21.58**
RLC 6 x LCK 88062	-43.40**	-34.13**	31.24**	-15.43**	-27.45**	-16.96**	34.07**	-3.44**	5.65**	-18.72**	13.92**	0.28
Garima x KL - 43	-30.75**	-32.22**	15.53**	-15.81**	-25.33**	-28.34**	22.06**	-10.54**	-29.72**	-46.72**	16.34**	-20.03**
Garima x LCK 88062	-34.00**	-40.46**	26.98**	-15.83**	-22.63**	-32.05**	30. 90**	-7.93**	-0.91	-34.17**	13.64**	-7.15**
KL 43 x LCK 88062	-56.00**	-40.46**	32.47**	-21.33**	-51.81*	-35.42**	44.03**	-14.40**	-10.91**	-13.86**	11.24**	-4.51**
S.E. ±	0.31	1.51	0.22	0.68	0.27	1.46	0.22	0.65	1.43	1.46	0.56	1.15

Table Contd:

6. No. of branches / plant

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	35.48**	36.87**	20.10**	30.82**	35.48**	49.72**	31.23**	38.81**	48.44**	40.86**	23.97**	37.76**
Neelum x Sweta	44.21**	66.27**	6.36	38.95**	45.74**	88.46**	23.61**	52.60**	42.74**	62.69**	16.94**	40.79**
Neelum x LMH-62	22.77**	44.74**	27.54**	31.68**	27.84**	59.96**	42.83**	43.54**	31.47**	60.59**	26.50**	39.52**
Neelum x DPL-21	15.05**	12.94**	17.75**	15.25**	22.29**	21.46**	22.65**	22.13**	25.00**	5.35	10.62**	13.66**
Neelum x J-23	39.58**	73.82**	14.03**	42.48**	41.80**	77.97**	15.56**	45.11**	43.60**	48.27**	13.76**	35.21**
Neelum x RLC-6	12.90**	124.03**	10.74**	49.22**	16.02**	127.41**	13.69**	52.37**	41.01**	56.52**	20.04**	39.19**
Neelum x Garima	18.28**	59.00**	20.03**	32.44**	22.22**	60.02**	22.41**	34.88**	39.13**	35.17**	13.25**	29.18**
Neelum x KL-43	25.81**	10.45**	-10.71**	8.52**	35.26**	16.93**	-4.45	15.91**	45.18**	14.95**	-31.29**	9.61**
Neelum xLCK88062	34.41**	21.64**	13.92**	23.32**	49.70**	36.19**	46.58**	44.16**	53.78**	30.19**	31.33**	38.43**
Shubhra x Sweta	61.05**	68.63**	53.64**	61.11**	62.77**	75.38**	64.48**	67.54**	29.83**	46.79**	25.00**	33.87**
Shubhra x LMH-62	14.85**	66.24**	31.72**	37.94**	19.59**	68.14**	59.40**	49.04**	-21.81**	49.38**	40.94**	22.84**
Shubhra x DPL-21	62.37**	50.41**	24.85**	45.88**	72.57**	53.21**	31.26**	52.36**	23.08**	12.67**	20.29**	18.68**
Shubhra x J-23	88.54**	72.02**	17.46**	59.34**	91.53**	92.24**	29.91**	71.23**	52.85**	44.59**	20.00**	39.15**
Shubhra x RLC-6	50.54**	78.26**	17.17**	48.66**	54.70**	92.34**	31.12**	59.39**	19.34**	46.81**	20.22**	28.79**
Shubhra x Garima	56.99**	19.67**	11.47**	29.38**	62.22**	31.67**	19.61**	37.83**	-2.75	21.00**	20.68**	12.98**
Shubhra x KL-43	26.88**	-13.69**	4.42	5.87*	36.42**	-0.59	6.79*	14.21**	12.46**	-12.57**	12.84**	4.24
Shubhra x LCK88062	77.42**	68.77**	7.59*	51.26**	97.60**	104.40**	29.03**	77.01**	56.51**	57.18**	30.89**	48.19**
Sweta x LMH – 62	48.51**	38.61**	24.86**	37.33**	53.06**	42.58**	59.40**	51.68**	4.47	9.67**	39.28**	17.81**
Sweta x DPL – 21	41.05**	27.98**	29.17**	32.73**	51.41**	35.48**	44.85**	43.91**	0.44	32.93**	27.96**	20.44**
Sweta x J 23	30.21**	35.88**	22.24**	29.46**	30.89**	57.19**	43.72**	43.93**	5.62*	33.65**	25.78**	21.68**
Sweta x RLC – 6	28.42**	-7.97**	18.08**	12.84**	33.33**	2.95	40.29**	25.52**	-10.60**	-0.33	27.04**	5.37
Sweta x Garima	41.05**	55.52**	16.40**	37.66**	47.25**	77.25**	33.03**	52.51**	-4.35	48.52**	22.93**	22.36**
Sweta x KL – 43	69.47**	40.86**	15.03**	41.79**	84.00**	67.71**	25.74**	59.15**	41.70**	51.87**	17.52**	37.03**
Sweta x LCK 88062	56.84**	59.52**	4.02	40.13**	76.33**	99.25**	17.60**	64.39**	54.56**	58.16**	2.25	38.32**
LMH62 x DPL – 21	23.76**	61.17**	16.11**	33.68**	36.61**	66.01**	34.76**	45.79**	5.77*	38.86**	29.26**	24.63**

Table : Contd....

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	83.17**	76.09**	-6.31	50.98**	87.82**	98.76**	3.67	63.42**	41.21**	49.73**	-16.25**	24.90**
LMH 62 x RLC – 6	24.75**	88.09**	23.14**	45.33**	33.33**	105.07**	34.65**	57.68**	8.36**	57.96**	42.95**	36.42**
LMH 62 x Garima	7.92**	40.25**	22.98**	23.72**	15.96**	55.90**	40.10**	37.32**	28.25**	57.70**	20.73**	35.56**
LMH 62 x KL – 43	5.94**	31.00**	9.16**	15.37**	18.23**	52.34**	29.72**	33.43**	-23.51**	10.79**	26.94**	4.74
LMH62 x LCK 88062	22.77**	22.53**	-21.90**	7.80**	41.71**	49.73**	8.79**	33.41**	3.47	23.03**	17.58**	14.69**
DPL - 21 x J 23	10.42**	24.76**	16.73**	17.30**	19.10**	37.12**	23.15**	26.46**	-22.02**	19.25**	13.75**	3.66
DPL - 21 x RLC - 6	22.73**	30.24**	17.89**	23.62**	27.06**	38.10**	25.93**	30.36**	-30.84**	19.79**	13.59**	0.84
DPL - 21 x Garima	34.48**	30.81**	31.20**	32.16*	38.46**	41.51**	34.06**	38.01**	-29.01**	19.00**	22.28**	4.09
DPL - 21 x KL - 43	26.83**	35.13**	26.58**	29.51**	28.40**	53.17**	30.21**	37.26**	-8.22**	27.59**	-0.08	6.43
DPL-21xLCK 88062	34.15**	2.65	23.88**	20.23**	41.03**	22.47**	54.60**	39.37**	4.43	6.70	26.54**	12.56**
J - 23 x RLC - 6	-6.25**	76.99**	17.38**	29.37**	-2.17	83.88**	18.93**	33.55**	-4.76	33.71**	15.46**	14.80**
J - 23 x Garima	1.04	36.75**	34.04**	23.94**	6.01**	39.13**	38.49**	27.88**	-1.46	18.79**	21.21**	12.85**
J - 23 x KL - 43	10.42**	1.99	15.93**	9.45**	20.45**	5.54*	25.61**	17.20**	6.75*	-28.38**	9.77**	-3.95
J - 23 x LCK 88062	7.29**	6.55*	28.12**	13.99**	21.18**	16.78**	66.42**	34.79**	0.85	-6.27	38.10*	10.89**
RLC 6 x Garima	27.27**	19.40**	9.20**	18.62**	28.00**	21.97**	14.27**	21.41**	-5.81*	25.83**	12.20**	10.74**
RLC 6 x KL - 43	11.36**	-10.30**	17.31**	6.12*	16.67**	-3.70	28.64**	13.87**	10.50**	-10.07**	24.55**	8.33*
RLC 6 x LCK 88062	50.00**	57.83**	6.36	38.06**	62.98**	79.04**	39.43**	60.48**	52.14**	29.57**	25.13**	35.61**
Garima x KL - 43	48.28**	62.80**	32.89**	47.94**	54.49**	71.31**	39.59**	55.13**	38.02**	51.92**	18.96**	36.30**
Garima x LCK 88062	40.23**	52.34**	14.93**	35.83**	51.55**	69.59**	45.78**	55.64**	50.77**	59.88**	30.42**	47.02**
KL 43 x LCK 88062	27.50**	36.33**	18.36**	27.40**	32.47**	44.70**	44.52**	40.56**	-2.37	-11.71**	21.58**	2.50
S.E. ±	2.26	2.73	3.37	2.79	1.92	2.51	3.05	2.49	2.70	3.46	3.78	3.31

Table : Number of Capsules/plant

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	1.52	10.17**	27.60**	13.10**	6.83	18.85**	38.91**	21.53**	54.32**	-5.40	20.92**	23.28**
Neelum x Sweta	1.56	19.49**	24.31**	15.12**	15.79**	31.88**	25.70**	24.46**	61.00**	33.94**	17.93**	37.62**
Neelum x LMH-62	0.86	9.67**	31.91**	14.15**	11.96**	37.55**	35.82**	28.44**	43.38**	38.43**	23.85**	35.22**
Neelum x DPL-21	10.78*	12.90**	36.54**	20.07**	21.96**	22.03**	41.51**	28.50**	29.59**	7.19*	22.13**	19.64**
Neelum x J-23	6.59	29.64**	-1.71	11.51**	13.84**	30.03**	0.66	14.86**	48.84**	3.66	-5.63	15.62**
Neelum x RLC-6	6.16	-14.19**	24.04**	5.48	29.53**	3.72	35.45**	22.90**	56.61**	7.04*	21.40**	28.35**
Neelum x Garima	0.81	31.98**	4.67	12.49**	10.40**	43.11**	16.75**	23.42**	29.72**	38.22**	-13.89**	18.02**
Neelum x KL-43	6.95	26.88**	14.60**	16.14**	12.82**	47.22**	19.76**	26.60**	48.65**	47.47**	18.12**	38.08**
Neelum xLCK88062	0.99	19.12**	25.09**	15.07**	17.48**	33.52**	32.38**	27.79**	36.55**	30.14**	19.49**	28.73**
Shubhra x Sweta	10.50*	76.20**	23.18**	36.63**	20.27**	108.09**	32.73**	53.70**	48.66**	31.71**	21.78**	34.05**
Shubhra x LMH-62	18.30**	-9.85**	34.30**	14.25**	25.18**	19.58**	50.14**	31.63**	35.96**	4.79	19.26**	20.00**
Shubhra x DPL-21	28.53**	11.98**	25.45**	21.99**	34.82**	29.73**	41.08**	35.21**	26.12**	-23.44**	15.35**	6.01
Shubhra x J-23	2.66	89.38**	27.83**	39.96**	4.29	103.66**	42.21**	50.05**	33.42**	9.34**	30.08**	24.28**
Shubhra x RLC-6	7.33	-3.61	34.79**	12.84**	25.57**	23.65**	35.25**	28.16**	37.81**	18.66**	17.73**	24.73**
Shubhra x Garima	4.74	6.96*	62.71**	24.80**	9.25**	24.29**	67.12**	33.55**	35.56**	-13.71**	34.75**	18.87**
Shubhra x KL-43	4.80	-7.40*	10.31**	2.57	5.09	14.46**	15.14**	11.56**	23.22**	5.01	6.82	11.86**
Shubhra x LCK88062	1.83	59.33**	10.47**	23.88**	13.24**	90.84**	13.84**	39.31**	11.36**	34.50**	8.33*	18.06**
Sweta x LMH – 62	-3.63	-7.68**	16.63**	1.77	-0.69	6.59*	21.39**	9.10**	-30.24**	-6.58	11.41**	-8.47*
Sweta x DPL – 21	23.03**	39.51**	29.10**	30.55**	27.92**	42.74**	35.25**	35.30**	30.02**	8.80*	18.37**	19.06**
Sweta x J 23	5.61	64.00**	3.49	24.37**	13.29**	81.56**	7.15*	34.00**	33.74**	22.87**	-21.24**	11.79**
Sweta x RLC – 6	12.02**	13.56.**	11.37**	12.32**	21.23**	25.76**	20.30**	22.48**	-3.24	24.47**	19.08**	13.44**
Sweta x Garima	12.33**	18.52**	9.18*	13.34**	17.46**	20.84**	20.57**	19.62**	26.44**	-8.38*	15.51**	11.19**
Sweta x KL – 43	22.91**	53.08**	46.26**	40.75**	33.45**	61.88**	51.22**	48.85**	46.65**	44.66**	25.76**	39.02**
Sweta x LCK 88062	-5.70	67.74**	54.87**	38.97**	-3.46	70.66**	62.16**	43.12**	16.58**	46.63**	35.02**	32.74**
LMH62 x DPL – 21	13.51**	-3.50	16.86**	8.96*	14.55**	13.58**	17.66**	15.26**	22.32**	22.08**	11.27**	18.56**

Table : Contd….

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	4.73	18.49**	23.49**	15.57**	9.16*	48.99**	24.17**	27.44**	12.82**	37.79**	15.93**	22.18**
LMH 62 x RLC – 6	17.34**	-6.95*	10.30**	6.90	30.59**	-2.48	23.68**	17.26**	0.44	-6.13	24.05**	6.12
LMH 62 x Garima	13.33**	0.47	25.98**	13.26**	15.04**	17.91**	44.19**	25.71**	14.09**	-4.07	17.41**	9.14*
LMH 62 x KL – 43	0.47	-4.32	9.75*	1.97	6.03	5.06	17.93**	9.67**	24.79**	9.30**	20.23**	18.11**
LMH62 x LCK 88062	14.02**	11.88**	16.64**	14.18**	20.21**	27.27**	26.87**	24.78**	-7.29	19.13**	12.53**	8.12*
DPL - 21 x J 23	3.36	77.66**	20.67**	33.90**	6.79	92.62**	22.15**	40.52**	16.56**	27.86**	17.49**	20.64**
DPL - 21 x RLC - 6	-5.10	25.77**	-10.17**	3.50	6.48	42.14**	1.32	16.65**	-19.25**	41.61**	-8.65*	4.57
DPL - 21 x Garima	17.06**	47.18**	18.97**	27.44**	17.75**	47.70**	36.96**	34.14**	24.98**	14.75**	17.71**	19.15**
DPL - 21 x KL - 43	-11.72*	18.28**	-1.84	1.57	-7.64	27.80**	6.14	8.77**	0.91	24.98**	9.07*	11.65**
DPL-21xLCK 88062	10.73*	37.70**	1.86	16.76**	17.75**	43.27**	11.48**	24.17**	17.47**	27.54**	14.82**	19.94**
J - 23 x RLC - 6	-10.98*	-21.58**	12.53**	-6.68	2.78	-4.96	25.56**	7.79*	-24.71**	-1.95	26.54**	-0.04
J - 23 x Garima	-11.81*	19.66**	4.00	3.95	-9.41*	30.16**	18.47**	13.07**	-15.79**	-4.67	20.44**	-0.01
J - 23 x KL - 43	0.94	2.20	-3.05	0.03	2.27	18.91**	3.65	8.23*	10.61**	24.06**	6.38	13.68**
J - 23 x LCK 88062	-17.92**	3.55	13.67**	-0.23	-10.01*	16.42**	23.02**	9.81**	-5.81	9.38**	21.03**	8.14*
RLC 6 x Garima	10.61*	-26.09**	24.97**	3.16	24.75**	-16.73**	27.93**	11.98**	39.22**	-0.27	11.48**	16.81**
RLC 6 x KL - 43	-14.03**	-19.45**	15.10**	-6.13	0.35	-15.41**	20.53**	1.82	14.66**	-12.49**	14.62**	5.60
RLC 6 x LCK 88062	12.66**	11.53**	43.54**	22.58**	19.32**	21.58**	48.41**	29.77**	19.19**	36.05**	21.60**	25.61**
Garima x KL - 43	-4.97	32.18**	1.05	9.42*	-1.14	42.36**	8.20*	16.47**	38.49**	40.28**	-9.55**	23.07**
Garima x LCK 88062	-7.33	59.22**	15.79**	22.56**	-0.91	65.10**	22.46**	28.88**	25.48**	48.46**	8.88*	27.67**
KL 43 x LCK 88062	-14.35**	20.68**	12.90**	6.41	-4.99	25.52**	14.39**	4.64	-10.40**	23.29**	7.92*	6.94
S.E. ±	4.70	3.13	3.84	3.89	4.00	2.76	3.30	3.35	3.94	3.50	3.66	3.70

Table : Number of seeds / capsule

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	2.52**	-6.47**	4.75**	0.27	2.52**	7.88**	5.49**	5.30**	5.93**	-13.15**	4.42**	-0.93*
Neelum x Sweta	6.28**	1.63**	7.41**	5.11**	11.10**	13.30**	14.50**	12.97**	33.40**	-5.61**	15.45**	14.41**
Neelum x LMH-62	8.39**	0.39**	3.68**	4.15**	10.33**	11.54**	8.10**	9.99**	29.36**	7.64**	9.22**	15.41**
Neelum x DPL-21	3.31**	-6.17**	10.12**	2.42**	8.23**	6.21**	18.11**	10.85**	25.32**	-3.56**	18.42**	13.39**
Neelum x J-23	16.29**	2.87**	17.81**	12.32**	17.57**	14.09**	18.34**	16.67**	37.78**	11.04**	9.14**	19.32**
Neelum x RLC-6	16.67**	0.56**	-13.44**	1.26**	20.52**	16.13**	-3.91**	10.91**	37.83**	-4.30**	-8.75**	8.26**
Neelum x Garima	15.56**	-1.89**	3.08**	5.58**	16.55**	11.52**	7.45**	11.84**	39.96**	13.54**	8.05**	20.52**
Neelum x KL-43	25.21**	-1.46**	8.26**	10.67**	28.55**	12.33**	11.23**	17.37**	41.49**	1.35**	10.10**	17.65**
Neelum xLCK88062	10.34**	-1.46**	7.45**	5.45**	16.32**	10.87**	10.38**	12.52**	35.52**	-1.65**	8.18**	14.02**
Shubhra x Sweta	30.45**	27.36**	-6.35**	17.15**	36.37**	32.36**	0.49	23.07**	30.85**	-11.19**	-8.78**	3.63**
Shubhra x LMH-62	1.45**	-3.32**	-10.02**	-3.96**	3.26**	0.84**	-5.55**	-0.48	3.38**	-46.98**	-5.55**	-16.38**
Shubhra x DPL-21	9.67**	5.31**	2.75**	5.91**	14.89**	7.62**	10.92**	11.14**	11.72**	-35.86**	14.49**	-3.22**
Shubhra x J-23	20.45**	1.17**	1.28*	7.63**	21.78**	5.74**	2.44**	9.99**	26.51**	-43.38**	2.96**	-4.64**
Shubhra x RLC-6	14.51**	3.62**	2.32**	6.82**	18.28**	3.77**	14.29**	12.11**	18.89**	-63.94**	20.80**	-8.08**
Shubhra x Garima	18.44**	2.65**	9.06**	10.05**	19.46**	4.42**	14.45**	12.78**	19.51**	-17.47**	11.42**	4.49**
Shubhra x KL-43	26.65**	5.96**	11.42**	14.68**	30.04**	7.43**	15.26**	17.58**	25.29**	-36.44**	11.29**	0.04
Shubhra x LCK88062	-5.13**	15.98**	4.95**	5.27**	0.52*	19.33**	8.55**	9.47**	11.09**	-27.04**	7.87**	-2.69**
Sweta x LMH – 62	20.77**	5.68**	3.40**	9.95**	24.09**	6.08**	5.82**	12.00**	16.31**	-14.24**	4.18**	2.08**
Sweta x DPL – 21	26.02**	17.49**	11.88**	18.46**	26.30**	19.52**	12.60**	19.47**	35.19**	-18.24**	3.68**	6.88**
Sweta x J 23	-0.77**	2.67**	-0.45	0.48	4.82**	3.27**	5.68**	4.59**	23.22**	-13.79**	8.33**	-0.08
Sweta x RLC – 6	13.73**	18.73**	14.42**	15.63**	22.63**	23.56**	19.50**	21.90**	35.48**	-16.50**	14.54**	11.17**
Sweta x Garima	8.85**	2.91**	14.41**	8.72**	14.73**	5.18**	17.12**	12.34**	33.77**	-43.26**	11.25**	0.59
Sweta x KL – 43	23.93**	18.89**	29.13**	23.98**	26.24**	21.91**	34.12**	27.42**	35.98**	-26.69**	17.56**	8.95**
Sweta x LCK 88062	5.50**	13.28**	-6.54**	4.08**	16.55**	14.45**	-2.91**	9.36**	35.14**	-25.25**	-10.06**	-0.06
LMH62 x DPL – 21	21.07**	-3.43**	4.10**	7.25**	24.67**	-1.39**	7.22**	10.17**	30.21**	-37.33**	4.62**	-0.83

Table : Contd....

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	11.80**	-2.56**	21.36**	10.20**	15.03**	-2.35**	26.00**	12.89**	21.29**	-42.09**	19.79**	-0.34
LMH 62 x RLC – 6	5.61**	3.27**	2.29**	3.72**	10.98**	7.86**	9.23**	9.36**	29.49**	-56.59**	11.21**	-5.30**
LMH 62 x Garima	13.81**	0.00	11.11**	8.31**	16.82**	2.58**	11.09**	10.16**	21.48**	-17.09**	7.26**	3.88**
LMH 62 x KL – 43	19.74**	7.02**	13.13**	13.30**	20.80**	10.14**	14.85**	15.26**	31.80**	-18.17**	10.89**	8.17**
LMH62 x LCK 88062	1.72**	7.45**	7.44**	5.54**	9.60**	8.96**	9.09**	9.22**	20.58**	-48.11**	6.57**	-6.99**
DPL - 21 x J 23	13.54**	-2.08**	18.38**	9.95**	20.20**	0.19	26.44**	15.61**	35.81**	-57.84**	18.98**	-1.02*
DPL - 21 x RLC - 6	14.20**	10.61**	19.19**	14.67**	23.39**	13.21**	23.71**	20.10**	38.11**	-28.59**	21.92**	10.48**
DPL - 21 x Garima	6.78**	3.91**	11.55**	7.41**	12.78**	4.41**	14.91**	10.70**	26.66**	-36.08**	9.25**	-0.06
DPL - 21 x KL - 43	24.98**	4.58**	7.06**	12.51**	27.59**	5.44**	11.89**	14.97**	34.88**	-33.71**	7.87**	3.01**
DPL-21xLCK 88062	7.30**	3.69**	16.59**	9.19**	18.77**	4.41**	21.88**	15.02**	31.72**	-44.90**	10.41**	-0.92**
J - 23 x RLC - 6	0.54*	-3.73**	-10.62**	-4.60**	2.75**	0.75**	-1.17	0.79*	29.36**	-15.18**	4.75**	6.31**
J - 23 x Garima	-1.50**	-3.09**	4.13**	-0.15	-1.26**	-0.38**	8.08**	2.15**	18.75**	-31.26**	8.94**	-1.19**
J - 23 x KL - 43	5.70**	-4.27**	-12.05**	-3.54**	9.69**	-1.27**	-10.03**	-0.54	28.87**	-50.64**	-19.69**	-13.82**
J - 23 x LCK 88062	1.76**	3.31**	23.24**	-9.44**	6.71**	4.99**	26.05**	12.58**	32.54**	-40.68**	18.79**	3.55**
RLC 6 x Garima	-7.93**	0.79**	4.14**	-1.00**	-5.69**	2.67**	11.23**	2.74**	24.16**	-30.11**	9.01**	1.02*
RLC 6 x KL - 43	14.82**	3.63**	-11.08**	2.46**	7.97**	5.22**	-3.71**	3.16**	31.02**	-28.27**	-8.66**	-1.97**
RLC 6 x LCK 88062	-7.39**	4.02**	1.97**	-0.47	-9.86**	7.18**	10.44**	2.59**	25.02**	-27.33**	12.96**	3.55**
Garima x KL - 43	2.76**	20.47**	15.65**	12.96**	6.39**	20.88**	17.39**	14.89**	29.37**	-15.92**	10.10**	7.85**
Garima x LCK 88062	-5.17**	1.60**	16.50**	4.31**	-0.33	2.79**	18.27**	6.91**	29.43**	-31.34**	12.00**	3.36**
KL 43 x LCK 88062	-0.99**	2.48**	25.31**	8.93**	7.55**	4.03**	25.34**	12.31**	20.89**	-28.12**	17.16**	3.31**
S.E. ±	0.23	0.15	0.65	0.34	0.21	0.13	0.65	0.33	0.22	0.47	0.65	0.45

Table : 1000 Seed Weight (g.)

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	2.83**	3.27**	5.15	3.75**	15.43**	4.87**	16.22**	12.17**	31.67**	-21.27**	17.51*	9.30**
Neelum x Sweta	2.27**	5.39**	6.97*	4.88**	4.89**	6.03**	10.79**	7.24**	33.38**	4.98*	9.31**	15.89**
Neelum x LMH-62	0.77**	3.27**	-2.65	0.46	8.96**	8.96**	6.48	8.13**	29.41**	-12.91**	10.35**	8.95**
Neelum x DPL-21	4.13**	5.79**	5.80	5.24**	15.09**	13.83**	17.35**	15.42**	39.56**	1.93	17.72**	19.74**
Neelum x J-23	4.70**	9.58**	1.93	5.40**	15.69**	17.29**	8.33*	13.77**	42.38**	8.23**	4.79	18.47**
Neelum x RLC-6	7.60**	6.21**	4.09	5.97**	31.35**	15.26**	7.51*	18.04**	43.28**	-3.97	8.08*	15.80**
Neelum x Garima	0.17	7.59**	10.80**	6.19**	8.80**	15.57**	12.48**	12.28**	40.87**	-8.99**	9.32**	13.73**
Neelum x KL-43	2.97**	-6.69**	17.50**	4.59**	17.01**	0.05	30.53**	15.86**	41.18**	-38.33**	18.96**	7.27**
Neelum xLCK88062	9.47**	12.57**	0.98	7.67**	27.34**	13.16**	6.41	15.64**	44.46**	10.96**	9.38**	21.60**
Shubhra x Sweta	-2.84**	4.45**	-3.09	-0.49	6.60**	6.70**	3.68	5.66**	21.38**	-24.54**	-1.64	-1.60
Shubhra x LMH-62	-1.14**	7.53**	9.14**	5.18**	2.98**	11.80**	10.41**	8.40**	10.75**	-28.48**	8.71**	-3.00
Shubhra x DPL-21	10.73**	-9.88**	8.94**	3.26**	12.07**	-4.41**	9.37**	5.68**	18.62**	-39.52**	4.68	-5.41**
Shubhra x J-23	9.67**	6.70**	-0.04	5.44**	11.62**	12.57**	4.23	9.47**	16.32**	-28.06**	3.87	-2.62
Shubhra x RLC-6	18.08**	4.79**	1.09	7.99**	30.00**	12.12**	8.44*	16.85**	16.58**	-25.63**	2.24	-2.27
Shubhra x Garima	-3.72**	0.78**	4.70	0.59	-0.18	6.71**	17.29**	7.94**	7.86**	-33.40**	6.11	-6.48**
Shubhra x KL-43	6.91**	24.41**	6.97*	12.76**	8.41**	31.49**	7.58*	15.83**	9.53**	-18.56**	3.15	-1.96
Shubhra x LCK88062	24.31**	9.88**	3.33	12.51**	29.47**	10.99**	8.70*	16.39**	32.52**	-35.34**	5.59	0.92
Sweta x LMH – 62	1.51**	4.83**	2.36	2.90*	7.17**	11.24**	8.33*	8.91**	22.95**	-6.71**	10.65**	8.96**
Sweta x DPL – 21	4.00**	4.40**	2.03	3.48**	12.29**	12.98**	9.57**	11.61**	25.84**	-4.49	11.96**	11.10**
Sweta x J 23	4.84**	10.82**	14.08**	9.91**	13.18**	19.29**	17.18**	16.55**	38.35**	1.61	2.07	14.01**
Sweta x RLC – 6	3.58**	12.65**	8.66*	8.30**	23.90**	22.94**	8.97**	18.60**	26.12**	-3.95	6.78*	12.28**
Sweta x Garima	-0.18	5.48**	3.68	2.99*	5.88**	13.95**	8.94**	9.59**	24.71**	-26.57**	2.94	0.36
Sweta x KL – 43	-0.11	1.22**	26.16**	9.09**	10.99**	9.15**	35.68**	18.61**	27.64**	-5.83*	20.25**	14.02**
Sweta x LCK 88062	2.88**	-5.58**	1.14	-0.52	17.09**	-4.50**	2.96	5.18**	13.27**	-21.59**	2.49	-1.94
LMH62 x DPL – 21	11.30**	6.89**	13.03**	10.41**	13.98**	9.14**	14.79**	12.64**	21.15**	-33.10**	3.28	-2.89

Table : Contd....

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	3.37**	12.66**	2.28	6.10**	5.84**	14.39**	5.47	8.57**	15.45**	-32.63**	3.99	-4.40*
LMH 62 x RLC – 6	9.95**	15.10**	2.67	9.14**	25.22**	18.58**	8.95**	17.58**	15.38**	-42.71**	8.75**	-6.19**
LMH 62 x Garima	4.47**	10.54**	18.04**	11.02**	4.99**	12.66**	30.89**	16.18**	9.73**	-19.12**	5.04	-1.45
LMH 62 x KL – 43	9.73**	21.29**	42.39**	24.47**	15.84**	23.38**	44.84**	28.02**	19.52**	-7.95**	3.79	5.12*
LMH62 x LCK 88062	5.92**	-2.21**	11.94**	5.22**	14.72**	2.67**	16.45**	11.28**	20.00**	-16.72**	4.03	2.44
DPL - 21 x J 23	10.00**	8.96**	1.85	6.94**	9.98**	9.59**	6.61	8.73**	24.48**	-18.85**	8.52*	4.72*
DPL - 21 x RLC - 6	-0.16	25.58**	0.89	8.77**	11.65**	26.74**	8.62*	15.67**	12.29**	-9.72**	10.87**	4.48*
DPL - 21 x Garima	11.25**	18.55**	12.09**	13.96**	13.39**	18.78**	26.01**	19.39**	22.61**	-41.61**	24.56**	1.86
DPL - 21 x KL - 43	15.07**	31.58**	22.12**	22.92**	18.71**	32.09**	22.32**	24.37**	25.33**	-7.87**	16.15**	11.20**
DPL-21xLCK 88062	1.19**	5.90**	3.33	3.47**	7.17**	13.40**	9.11**	9.89**	6.83**	-10.91**	8.82**	1.58
J - 23 x RLC - 6	-15.76**	11.09**	-1.29	-1.13	-5.78**	12.75**	1.67	2.88*	2.54**	-35.84**	3.32	-9.99**
J - 23 x Garima	1.78**	17.42**	0.59	6.60**	3.71**	17.87**	8.42*	10.00**	11.52**	-21.07**	11.66**	0.70
J - 23 x KL – 43	-4.57**	0.93**	584.54**	193.63**	-1.53**	1.17**	617.68**	205.77**	7.12**	-49.95**	85.30**	14.16**
J - 23 x LCK 88062	-7.12**	8.72**	3.29	1.63	-1.61**	15.80**	4.33	6.14**	-6.34**	-33.38**	2.25	-12.49**
RLC 6 x Garima	-6.70**	0.94**	16.24**	3.49**	6.10**	2.05**	21.82**	9.99**	13.63**	-37.73**	19.13**	-1.66
RLC 6 x KL – 43	3.07**	18.09**	11.77**	10.98**	12.04**	19.63**	20.52**	17.40**	8.51**	-26.93**	21.90**	1.16
RLC 6 x LCK 88062	22.10**	2.92**	5.30	10.11**	29.39**	11.16**	7.50*	16.02**	29.87**	-17.09**	1.88	4.89*
Garima x KL - 43	-0.24	6.09**	1.84	2.56*	4.83**	6.29**	14.65**	8.59**	27.16**	-14.42**	10.21**	7.65**
Garima x LCK 88062	-18.23**	-7.67**	11.17**	-4.91**	-11.83**	-1.31**	18.81**	1.89	-4.36**	-20.09**	4.23	-6.74**
KL 43 x LCK 88062	-4.91**	-7.96**	7.13*	-1.91	-2.30**	-1.79**	13.29**	3.07*	10.75**	-19.06**	11.34**	1.01
S.E. ±	0.13	0.22	3.38	1.24	0.12	0.21	3.38	1.24	0.21	2.40	3.38	2.00

Table : Harvest index (%)

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	15.61**	5.23*	10.78**	10.54**	17.43**	15.02**	19.29**	17.25**	23.14**	0.94	18.73**	14.27**
Neelum x Sweta	14.39**	12.57**	10.80**	12.59**	25.89**	16.04**	17.15**	19.69**	33.47**	-8.01**	3.48	9.65**
Neelum x LMH-62	9.43**	19.69**	3.13	10.75**	18.31**	20.26**	10.57**	16.38**	33.03**	23.09**	13.15**	23.09**
Neelum x DPL-21	14.61**	5.50**	5.01*	8.37**	24.09**	17.26**	11.18**	17.51**	19.23**	-14.17**	11.03**	5.36*
Neelum x J-23	12.23**	16.25**	4.42*	10.97**	16.57**	35.26**	10.39**	20.74**	34.08**	20.29**	8.67**	21.21**
Neelum x RLC-6	11.81**	7.69**	8.22**	9.24**	21.82**	23.40**	13.24**	19.49**	41.03**	-8.54**	7.47**	13.32**
Neelum x Garima	11.30**	11.92**	9.75**	10.99**	13.16**	18.45**	17.17**	16.26**	38.58**	24.47**	13.68**	25.58**
Neelum x KL-43	12.29**	6.57**	6.35**	8.40**	27.53**	10.40**	12.99**	16.97**	8.21**	-12.00**	9.41**	1.87
Neelum xLCK88062	16.59**	18.47**	17.10**	17.39**	16.64**	19.11**	17.28**	17.68**	26.86**	23.18**	7.50**	19.18**
Shubhra x Sweta	22.16**	34.01**	11.75**	22.64**	36.34**	42.37**	26.68**	35.13**	23.46**	-6.90**	24.42**	13.66**
Shubhra x LMH-62	-7.86**	-10.18**	14.33**	-1.24	-1.83	-1.40	14.86**	3.88*	4.78*	-27.37**	10.20**	-4.13
Shubhra x DPL-21	3.93*	24.54**	4.97**	11.15**	14.15**	26.87**	19.15**	20.06**	-3.31	-20.19**	14.72**	-2.93
Shubhra x J-23	8.76**	5.04*	7.75**	7.18**	14.67**	12.57**	9.88**	12.37**	13.80**	-25.57**	4.95	-2.27
Shubhra x RLC-6	4.10*	53.02**	3.05	20.06**	15.04**	61.22**	15.70**	30.65**	0.77	3.88	9.81**	4.82*
Shubhra x Garima	2.98	-1.16	8.67**	3.50	6.32**	13.71**	9.68**	9.90**	7.07**	-1.55	8.84**	4.79*
Shubhra x KL-43	15.07**	22.89**	4.16*	14.04**	32.46**	29.92**	18.60**	26.99**	2.86	-14.54**	10.44**	-0.41
Shubhra x LCK88062	16.60**	33.70**	11.35**	20.55**	18.39**	46.84**	19.73**	28.32**	18.78**	17.97**	14.85**	17.2**
Sweta x LMH – 62	-11.77**	8.14**	12.45**	2.94	4.13**	11.98**	26.95**	14.35**	-11.30**	-27.34**	14.38**	-8.09**
Sweta x DPL – 21	23.41**	35.44**	11.47**	23.44**	25.62**	46.40**	11.63**	27.88**	20.46**	-0.23	11.67**	10.63**
Sweta x J 23	6.17**	14.21**	-4.07	5.44**	12.76**	29.45**	6.88**	16.36**	3.55	-22.01**	4.60	-4.62
Sweta x RLC – 6	27.01**	23.18**	5.16*	18.45**	28.42**	37.42**	6.32**	24.05**	24.69**	-8.19**	5.38	7.29**
Sweta x Garima	31.99**	5.00*	3.05	13.35**	43.06**	14.34**	15.88**	24.43**	8.77**	-11.97**	20.86**	5.89*
Sweta x KL – 43	51.36**	36.13**	4.88*	30.79**	56.76**	36.83**	5.41**	33.00**	17.66**	1.05	3.07	7.26**
Sweta x LCK 88062	27.54**	21.53**	10.39**	19.82**	40.41**	25.92**	16.90**	27.74**	17.84**	-10.22**	6.35*	4.66
LMH62 x DPL – 21	-12.65**	-15.35**	2.60	-8.47**	1.57	-5.52**	15.98**	4.01*	2.60	-16.92**	19.92**	1.87

Table : Contd....

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	-14.24**	4.08*	6.81**	-1.12	-3.99**	21.57**	8.42**	8.67**	-15.73**	-17.07**	8.20**	-8.20**
LMH 62 x RLC – 6	-13.96**	30.37**	10.32**	8.91**	0.62	49.99**	23.36**	24.66**	2.73	25.94**	11.15**	13.27**
LMH 62 x Garima	-9.92**	-9.65**	9.16**	-3.47	-1.12	-4.80**	9.56**	1.25	-0.21	-13.68**	9.44**	-1.48
LMH 62 x KL – 43	-8.74**	7.45**	2.84	0.52	10.84**	11.81**	16.21**	12.95**	-0.78	-13.94**	12.31**	-0.80
LMH62 x LCK 88062	-8.38**	-13.81**	2.97	-6.41**	-0.99	-13.75**	10.24**	-1.5	-8.89**	-47.68**	8.15**	-16.14**
DPL - 21 x J 23	12.13**	20.96**	4.48*	12.52**	17.09**	27.37**	16.56**	20.34**	24.49**	-26.29**	19.84**	6.01*
DPL - 21 x RLC - 6	24.79**	44.99**	-4.47*	21.77**	25.64**	50.06**	-3.28	24.14**	8.86**	21.70**	-8.91**	7.22**
DPL - 21 x Garima	5.56**	5.45**	3.45	4.82*	12.54**	23.24**	16.48**	17.42**	-18.22**	-4.19	46.06**	7.88**
DPL – 21 x KL - 43	28.45**	28.30**	18.65**	25.13**	35.33**	38.03**	19.08**	30.81**	14.42**	7.92**	34.17**	18.77**
DPL-21xLCK 88062	5.12**	2.70	8.34**	5.39**	13.87**	14.69**	14.88**	14.48**	5.45**	-9.12**	13.68**	3.34
J - 23 x RLC - 6	-0.54**	33.25**	4.13*	12.28**	4.54**	35.66**	14.88**	18.36**	3.67	-11.14**	12.91**	1.81
J - 23 x Garima	6.44**	-2.62	9.13**	4.32*	8.77**	18.78**	10.28**	12.61**	-3.26	-1.46	7.79**	1.02
J - 23 x KL – 43	-3.59*	9.06**	-2.06	1.14	5.82**	23.06**	9.61**	12.83**	-21.80**	-20.34**	39.70**	-0.81
J - 23 x LCK 88062	6.95**	3.95	2.08	4.33*	11.13**	21.49**	7.76**	13.46**	-2.30	-19.91**	9.53**	-4.50
RLC 6 x Garima	-1.91	-14.84**	8.71**	-2.68	5.24**	2.41	21.06**	9.57**	3.98*	-9.06**	17.00**	3.97
RLC 6 x KL – 43	27.79**	10.61**	16.19**	18.20**	33.77**	22.84**	18.06**	24.89**	6.01**	-9.85**	7.73**	1.30
RLC 6 x LCK 88062	-7.15**	11.33**	6.20**	3.46	1.20	28.16**	11.29**	13.55**	-0.17	10.76**	11.25**	7.28**
Garima x KL - 43	10.29**	-26.38**	2.33	-6.14**	23.44**	-19.46**	15.58**	6.52**	17.70**	-37.09**	3.54	-5.28**
Garima x LCK 88062	13.38**	0.50	5.55**	6.48**	15.32**	5.83**	12.53**	11.24**	16.80**	-2.07	7.30*	7.34**
KL 43 x LCK 88062	2.23	-23.12**	3.54	-5.78**	16.15**	-19.95**	10.16**	2.12	25.84**	-51.99**	3.35	-7.60**
S.E. ±	1.83	2.05	2.08	1.99	1.54	1.80	1.74	1.69	1.94	2.38	2.87	2.40

Table : Fibre yield /plant (g.)

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	4.44**	15.24**	4.57**	8.08**	26.36**	63.21**	45.19**	44.92**	18.56**	9.07**	54.70**	27.44**
Neelum x Sweta	8.15**	11.76**	2.63**	7.51**	67.82**	60.08**	44.30**	57.40**	67.58**	58.70**	50.61**	58.96**
Neelum x LMH-62	1.85**	2.32**	-43.63**	-13.15**	53.06**	37.56**	-21.28**	23.11**	66.91**	56.74**	-62.65**	20.33**
Neelum x DPL-21	10.91**	25.86**	4.17**	13.65**	30.80**	40.47**	29.01**	33.42**	73.97**	71.51**	31.89**	59.12**
Neelum x J-23	5.43**	7.55**	2.91**	5.30**	21.57**	27.21**	29.11**	25.96**	-1.87**	-58.43**	35.53**	-8.26**
Neelum x RLC-6	10.49**	-9.14**	3.19**	1.51**	65.74**	16.36**	40.43**	40.84**	46.82**	31.47**	45.10**	41.13**
Neelum x Garima	10.25**	17.42**	-1.66**	8.67**	50.84**	49.12**	39.63**	46.53**	56.66**	58.10**	51.69**	55.48**
Neelum x KL-43	5.56**	52.87**	37.25**	31.89**	8.71**	75.06**	44.28**	42.68**	53.68**	79.09**	31.51**	54.76**
Neelum xLCK88062	27.87**	25.21**	31.68**	28.25**	38.57**	37.35**	52.16**	42.69**	24.65**	23.66**	43.04**	30.45**
Shubhra x Sweta	12.48**	62.32**	16.35**	30.38**	55.96**	65.53**	18.78**	46.76**	-33.45**	-63.77**	10.27**	-28.98**
Shubhra x LMH-62	154.82**	244.35**	13.21**	133.06**	238.27**	273.23**	14.29**	175.26**	42.88**	35.96**	9.72**	29.52**
Shubhra x DPL-21	-31.53**	-38.62**	19.42**	-16.91**	-5.85**	-7.45**	87.94**	24.88**	11.54**	23.78**	73.25**	36.19**
Shubhra x J-23	2.52**	16.39**	9.32**	9.41**	8.54**	45.79**	25.57**	26.63**	-79.51**	-120.76**	22.39**	-59.29**
Shubhra x RLC-6	23.25**	22.48**	13.86**	19.86**	63.20**	41.28**	17.50**	40.66**	-13.65**	-56.75**	9.33**	-20.36**
Shubhra x Garima	74.29**	23.74**	19.81**	39.28**	104.21**	44.12**	24.31**	57.55**	32.10**	-52.04**	12.60**	-2.49**
Shubhra x KL-43	57.93**	6.39**	41.50**	35.27**	86.53**	62.72**	102.50**	83.92**	32.86**	27.70**	54.86**	38.47**
Shubhra x LCK88062	-65.55**	-35.96**	19.43**	-27.36**	-55.62**	-4.37**	80.70**	6.90**	-327.58**	-104.85**	62.46**	-123.32**
Sweta x LMH – 62	23.51**	40.77**	12.18**	25.49**	31.87**	55.34**	13.45**	33.55**	-39.27**	23.89**	7.43**	-2.65**
Sweta x DPL – 21	-57.47**	-47.59**	0.94**	-34.71**	-29.18**	-20.21**	60.24**	3.62**	-133.74**	-207.46**	67.17**	-91.34**
Sweta x J 23	40.67**	11.55**	12.59**	21.60**	101.93	41.79**	31.61**	58.44**	36.20**	11.68**	17.18**	21.69**
Sweta x RLC – 6	319.63**	141.09**	17.99**	159.57**	349.60**	182.73**	24.22**	185.52**	51.10**	58.63**	10.75**	40.16**
Sweta x Garima	228.61**	199.24**	17.05**	148.30**	304.28**	254.26**	19.00**	192.51**	61.43**	67.85**	8.40**	45.89**
Sweta x KL – 43	-10.35**	-30.99**	9.88**	-10.49**	37.21**	6.52**	59.10**	34.28**	28.36**	-77.71**	56.88**	2.51**
Sweta x LCK 88062	-63.47**	-34.89**	13.66**	-28.23**	-41.28**	-1.80**	73.70**	10.21**	-180.57**	-116.51**	58.06**	-79.67**
LMH62 x DPL – 21	19.07**	14.71**	7.67**	13.82**	93.58**	65.51**	70.12**	76.40**	65.87**	59.92**	61.39**	62.39**

Table : Contd....

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	106.89**	74.58**	10.49**	63.98**	185.28**	104.68**	27.94**	105.97**	62.96**	57.04**	19.20**	46.40**
LMH 62 x RLC – 6	399.26**	148.06**	27.73**	191.48**	401.12**	165.56**	33.03**	200.03**	60.61**	8.44**	15.01**	28.02**
LMH 62 x Garima	217.11**	192.93**	12.50**	140.85**	269.49**	216.94**	15.65**	167.39**	21.33**	3.19**	6.84**	10.45**
LMH 62 x KL – 43	82.70**	5.31**	12.37**	33.46**	170.42**	54.41**	61.69**	95.51**	14.99*	-30.04**	59.07**	14.67**
LMH62 x LCK 88062	-19.73**	-31.30**	10.02**	-13.67**	25.45**	-1.96**	67.23**	30.24**	17.17**	17.57**	56.67**	30.47**
DPL – 21 x J 23	-21.82**	13.91**	16.70**	2.93**	3.47**	47.25**	70.93**	40.55**	-9.67**	-38.24**	64.82**	5.55**
DPL – 21 x RLC - 6	-8.85**	9.77**	6.05**	2.32**	47.98**	51.95**	64.57**	54.83**	21.68**	-30.37**	69.56**	20.29**
DPL – 21 x Garima	-22.25**	11.72**	7.84**	0.90**	17.69**	53.55**	72.36**	47.87**	-6.08**	-30.25 **	70.77**	11.44**
DPL – 21 x KL - 43	-12.80**	-13.76**	3.49**	-7.69**	5.35**	-11.21**	23.10**	5.75**	-14.29**	-52.64**	30.64**	-12.30**
DPL-21xLCK 88062	4.21**	11.15**	14.74**	10.03**	14.33**	13.30**	24.61**	17.41**	19.87**	-39.30**	8.24**	-3.73**
J - 23 x RLC - 6	27.90**	-4.41**	15.15**	12.88**	75.95**	5.45**	28.65**	33.68**	-30.22**	-128.13**	14.98**	-47.79**
J - 23 x Garima	-3.36**	7.98**	8.86**	4.49**	18.68**	17.85**	29.01**	21.86**	-66.09**	-114.98**	18.63**	-54.15**
J - 23 x KL – 43	14.29**	3.47**	37.25**	18.33**	28.42**	36.53**	78.68**	47.88**	-11.47**	-1.68**	57.01**	14.62**
J - 23 x LCK 88062	-19.21**	3.94**	19.94**	1.56**	-0.32**	32.52**	67.25**	33.15**	-2.84**	-22.07**	58.65**	11.25**
RLC 6 x Garima	66.04**	4.29**	12.09**	27.47**	92.86**	5.49**	19.87**	39.41**	26.73**	0.97**	11.84**	13.18**
RLC 6 x KL – 43	4.06**	-7.80**	29.75**	8.67**	53.73**	29.92**	82.27**	55.31**	35.26**	59.69**	60.40**	51.78**
RLC 6 x LCK 88062	-70.46**	-40.14**	11.84**	-32.92**	-53.91**	-18.14**	66.54**	-1.84**	-237.47**	-50.10**	60.63**	-75.64**
Garima x KL - 43	-23.33**	-44.42**	21.38**	-15.46**	2.90**	-22.21**	77.35**	19.35**	29.40**	0.39**	64.16**	31.32**
Garima x LCK 88062	-71.50**	-48.15**	7.49**	37.39**	-59.01**	-29.60**	65.55**	-7.69**	-211.72**	-2.07**	66.57**	-49.07**
KL 43 x LCK 88062	-68.37**	-47.24**	10.83**	-34.93**	-64.79**	-44.66**	22.48**	-28.99**	-69.31**	21.36**	24.75**	-7.73**
S.E. ±	0.11	0.13	0.13	0.12	0.09	0.12	0.12	0.11	0.13	0.15	0.13	0.14

Table : Oil content in (%)

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	0.25	1.29**	0.47	0.67	3.25**	3.96**	2.47**	3.23**	8.86**	3.82**	1.51**	4.73**
Neelum x Sweta	0.08	0.62	3.04**	1.28**	2.19**	4.40**	4.98**	3.86**	2.06**	1.48**	6.12**	3.22**
Neelum x LMH-62	0.11	1.63**	2.42**	1.39**	4.12**	4.43**	5.79**	4.78**	3.58**	0.70*	6.07**	3.45**
Neelum x DPL-21	1.15*	1.95**	0.51	1.20**	3.29**	3.58**	0.64*	2.50**	2.86**	-4.19**	0.68*	-0.22
Neelum x J-23	1.04	1.35**	3.35**	1.91**	2.37**	2.82**	4.16**	3.12**	0.87	1.30**	2.25**	1.47**
Neelum x RLC-6	1.38*	0.66	2.18**	1.41**	3.49**	4.03**	4.75**	4.09**	5.53**	6.08**	0.65*	4.09**
Neelum x Garima	3.44**	1.28**	2.27**	2.33**	3.69**	3.11**	3.87**	3.56**	0.21	-2.85**	2.91**	0.11
Neelum x KL-43	1.50**	-0.98**	1.32**	0.61	3.69**	1.67**	3.31**	2.89**	5.12**	-1.44**	3.80**	2.49**
Neelum xLCK88062	1.39**	2.74**	2.08**	2.07**	2.43**	3.55**	3.53**	3.17**	1.12*	-2.32**	5.12**	1.31**
Shubhra x Sweta	2.33**	-0.79*	3.40**	1.65**	3.22**	0.33	3.51**	2.35**	4.66**	-0.37	1.43**	1.91**
Shubhra x LMH-62	-1.29*	-0.72*	3.02**	0.34	-0.29	-0.61*	4.35**	1.15**	1.61**	-4.75**	3.90**	0.26
Shubhra x DPL-21	-3.18**	1.17**	0.82*	-0.40	-2.33**	2.21**	2.70**	0.86**	-1.33**	-5.33**	4.20**	-0.82**
Shubhra x J-23	0.93	5.27**	0.34	2.18**	5.27**	6.53**	3.13**	4.98**	4.70**	6.75**	5.25**	5.57**
Shubhra x RLC-6	0.10	-0.43	0.80	0.16	1.01*	0.28	1.33**	0.87*	4.78**	0.32	1.52**	2.21**
Shubhra x Garima	1.69**	2.41**	-0.04	1.35**	4.49**	3.26**	0.39	2.71**	3.29**	-2.22**	0.21	0.43
Shubhra x KL-43	0.39	-2.47**	2.05**	-0.01	1.22**	-2.43**	2.08**	0.29	4.44**	-5.32**	1.62**	0.25
Shubhra x LCK88062	2.26**	4.78**	-0.89**	2.05**	4.27**	6.71**	-0.32	3.55**	6.67**	2.03**	0.24	2.98**
Sweta x LMH – 62	-0.92	0.32	1.82**	0.41	0.95*	1.33**	3.25**	1.84**	3.34**	-4.46**	2.98**	0.62
Sweta x DPL – 21	0.43	-1.49**	4.85**	1.26**	0.44	0.64**	6.68**	2.59**	2.88**	-1.45**	6.75**	2.73**
Sweta x J 23	0.79	1.61**	3.84**	2.08**	4.25**	3.97**	6.61**	4.94**	1.62**	2.11**	6.90**	3.54**
**Sweta x RLC – 6	-0.49	-3.81**	0.48	-1.27**	-0.46	-3.42**	1.12**	0.92**	-3.70**	-4.97**	0.41	-2.75**
Sweta x Garima	4.63**	-0.69*	1.66**	1.87**	6.59**	1.25**	1.98**	3.27**	5.38**	0.22	0.81**	2.14**
Sweta x KL – 43	0.69	-1.05**	1.81**	0.48	0.74	0.02	1.89**	0.88*	0.41	-2.23**	1.24**	-0.19
Sweta x LCK 88062	4.00**	-0.47	4.80**	2.78**	5.14**	2.48**	5.29**	4.30**	8.01**	1.29**	4.26**	4.52**
LMH62 x DPL – 21	-2.44**	0.00	2.34**	-0.03	-0.59	1.15**	5.57**	2.04**	0.74	-2.70**	5.82**	1.29**

Table : Contd....

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	-2.15**	2.54**	0.84*	0.41	3.06**	3.89**	4.95**	3.97**	2.82**	-0.05	6.31**	3.03**
LMH 62 x RLC – 6	-1.78**	-1.04**	0.49	-0.78	0.12	-0.45	1.27**	0.31	0.15	-2.75**	1.23**	-0.46
LMH 62 x Garima	-1.92**	0.62	-0.22	-0.51	1.78**	1.58**	1.50**	1.62**	5.34**	-5.11**	2.55**	0.93**
LMH 62 x KL – 43	-3.13**	-1.83**	0.14	-1.61**	-1.34**	-1.75**	1.47**	-0.54	1.05**	-8.20**	1.58**	-1.86**
LMH62 x LCK 88062	-1.78**	1.94**	0.40	0.19	1.15*	3.94**	2.27**	2.45**	2.77**	-2.67**	3.29**	1.13**
DPL - 21 x J 23	2.72**	5.05**	1.35**	3.04**	6.24**	5.22**	2.29**	4.58**	4.35**	3.79**	3.79**	3.97**
DPL - 21 x RLC - 6	1.66**	-1.51**	4.30**	1.48**	1.69**	0.22	6.79**	2.90**	0.89	-6.95**	7.99**	0.64
DPL - 21 x Garima	2.08**	3.03**	0.82*	1.98**	3.99**	3.23**	2.27**	3.16**	3.60**	-0.02	3.22**	2.27**
DPL - 21 x KL - 43	1.57**	1.16**	2.66**	1.80**	1.63**	2.25**	4.53**	2.80**	2.77**	-2.73**	4.75**	1.60**
DPL-21xLCK 88062	2.92**	0.80*	3.42**	2.38**	4.03**	1.62**	4.76**	3.47**	6.28**	-4.98**	4.70**	2.00**
J - 23 x RLC - 6	-1.41**	0.21	2.46**	0.42	1.93**	2.12**	5.84**	3.30**	-2.38**	-3.58**	6.97**	0.34
J - 23 x Garima	0.95	0.13	2.22**	1.10**	2.51**	0.49	4.62**	2.54**	-0.72	-4.69**	3.13**	-0.76*
J - 23 x KL – 43	-2.89**	-4.30**	1.51**	-1.89**	0.49	-3.11**	4.30**	0.56	-2.17*	-6.90**	5.68**	-1.13**
J - 23 x LCK 88062	-1.03	-0.23	2.31**	0.35	1.29**	0.41	4.57**	2.09**	-2.47**	-4.47**	4.61**	-0.78*
RLC 6 x Garima	0.76	-1.13**	0.61	0.08	2. 61**	0.41	1.57**	1.53**	1.03*	-3.70**	1.05**	-0.54
RLC 6 x KL – 43	-0.48	-5.49**	2.77**	-1.07**	-0.39	-4.85**	3.35**	0.63	3.11**	-4.11**	2.32**	0.44
RLC 6 x LCK 88062	2.70*	1.32**	0.63	1.55**	3.77**	3.91**	1.73**	3.14**	8.51**	3.92**	2.07**	4.83**
Garima x KL - 43	-3.23**	-1.77**	1.06**	-1.31**	-1.37**	-0.91**	1.45**	-0.28	-1.49**	-3.53**	1.62**	-1.13**
Garima x LCK 88062	3.00**	2.94**	1.24**	2.39**	3.81**	3.98**	1.38**	3.06**	6.75**	0.99**	1.13**	2.96**
KL 43 x LCK 88062	-0.04	-1.07**	0.99	-0.04	1.10	0.79**	1.53**	1.14**	3.70**	0.72*	1.55**	1.99**
S.E. ±	0.54	0.35	0.33	0.41	0.47	0.30	0.28	0.35	0.46	0.31	0.27	0.35

Table : Seed yield per plant (g.)

Cross	Heterosis over superior parent				Heterosis over mid parent				Inbreeding depression			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Neelum x Shubhra	15.23**	8.98**	6.67**	10.29**	34.57**	23.56**	18.78**	25.64**	29.14**	1.75**	10.44**	13.78**
Neelum x Sweta	13.39**	13.09**	13.07**	13.18**	59.50**	22.27**	15.01**	32.26**	44.99**	-1.06**	7.53**	17.15**
Neelum x LMH-62	11.47**	35.13**	-0.04	15.52**	31.54**	65.15**	22.26**	39.65**	40.11**	51.26**	22.15**	37.84**
Neelum x DPL-21	13.96**	20.99**	1.32**	12.09**	48.83**	24.37**	10.94**	28.06**	-12.56**	-39.31**	11.60**	-13.42**
Neelum x J-23	16.91**	27.21**	4.29**	16.14**	17.31**	45.99**	9.67**	24.32**	34.41**	30.50**	-4.05**	20.29**
Neelum x RLC-6	27.47**	15.76**	49.11**	30.78**	37.68**	21.29**	58.19**	39.05**	52.42**	-2.56**	18.02**	22.63**
Neelum x Garima	1.21**	11.84**	-4.62**	2.81**	13.97**	23.62**	9.88**	15.82**	43.10**	31.41**	-11.36**	21.05*
Neelum x KL-43	3.87**	25.80**	5.41**	11.69**	14.36**	26.60**	5.76**	15.57**	2.89**	-15.62**	2.76**	-3.32**
Neelum xLCK88062	2.36**	10.01**	15.55**	9.31**	12.64**	18.74**	27.91**	19.76**	35.62**	17.53**	8.76**	20.64**
Shubhra x Sweta	129.15**	51.41**	15.66**	65.41**	187.89**	83.61**	30.74**	100.75**	45.51**	19.48**	29.76**	31.58**
Shubhra x LMH-62	-39.05**	-28.21**	5.53**	-20.58**	-18.48**	-3.39**	17.40**	-1.49**	-23.88**	-7.33**	21.97**	-3.08**
Shubhra x DPL-21	45.34**	9.12**	12.35**	22.27**	66.51**	20.71**	35.57**	40.93**	-67.35**	-63.29**	22.87**	-35.92**
Shubhra x J-23	11.63**	58.19**	32.11**	33.98**	30.74**	60.41**	40.33**	43.83**	12.11**	10.23**	9.39**	10.58**
Shubhra x RLC-6	55.69**	53.97**	26.80**	45.49**	69.53**	67.30**	48.77**	61.87**	21.67**	11.52**	21.92**	18.37**
Shubhra x Garima	-28.93**	-3.60**	3.40**	-9.71**	-8.48**	19.12**	7.45**	6.03**	-3.21**	-34.07**	2.35**	-11.64**
Shubhra x KL-43	57.24**	12.03**	0.89**	23.39**	67.92**	26.31**	12.68**	35.64**	12.13**	-25.43**	20.00**	2.23**
Shubhra x LCK88062	25.94**	38.03**	8.99**	24.32**	59.17**	67.15**	9.71**	45.34**	33. 33**	30.26**	6.75**	24.45**
Sweta x LMH – 62	-28.43**	-8.91**	22.22**	-5.04**	10.70**	4.17**	51.47**	22.11	-41.23**	-24.30**	29.30**	-12.08**
Sweta x DPL – 21	145.93**	27.33**	32.99**	68.75**	174.21**	41.19**	43.43**	48.28**	29.54**	-0.85**	19.00**	15.90**
Sweta x J 23	7.05**	-8.33**	4.82**	1.18**	50.89**	11.78**	12.02**	24.90**	21.84**	-65.61**	-3.80*	-15.86**
Sweta x RLC – 6	54.47**	30.33**	-0.96**	27.95**	106.62**	47.07**	3.39**	52.36**	25.00**	-11.20**	-1.79**	4.00**
Sweta x Garima	22.70**	21.00**	3.55**	15.75**	84.89**	23.94**	21.01**	43.28**	27.74**	-0.61*	23.04**	16.72**
Sweta x KL – 43	99.29**	52.55**	1.86**	51.23**	162.81**	65.90**	3.27**	77.33**	40.25**	24.41**	3.33**	22.66**
Sweta x LCK 88062	35.14**	48.41**	29.77**	37.77**	100.98**	48.68**	45.84**	65.17**	45.38**	16.07**	12.23**	24.56**
LMH62 x DPL – 21	-15.40**	-29.60 **	32.75**	-4.08**	23.57**	-12.10**	74.15**	28.54**	4.03**	7.35**	40.33**	17.24**

Table : Contd….

	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
LMH62 x J – 23	-19.61**	-11.61**	-1.64**	-10.95**	-5.40**	20.04**	15.42**	10.02**	-5.74**	-8.45**	16.84**	0.88**
LMH 62 x RLC – 6	-9.78**	-14.93**	10.52**	-4.73**	13.35**	7.78**	41.49**	20.87**	32.53**	18.93**	28.68**	26.71**
LMH 62 x Garima	-39.86**	-27.35**	16.35**	-16.95**	-36.53**	-18.66**	24.92**	-10.09**	-44.67**	-50.90*	23.46**	-24.04**
LMH 62 x KL – 43	-15.80**	-12.73**	1.89**	-8.88**	7.44**	7.18**	24.94**	19.89**	-0.71**	-63.20**	36.17**	-9.25**
LMH62 x LCK 88062	-12.31**	-21.37**	1.55**	-10.71**	-5.20**	-9.94**	13.63**	-0.50**	-16.14**	-34.21**	13.34**	-12.34**
DPL - 21 x J 23	20.92**	20.10**	36.01**	25.68**	58.29**	34.53**	55.92**	49.58**	25.83**	42.19**	23.02**	30.35**
DPL - 21 x RLC - 6	50.88**	49.10**	15.96**	38.65**	85.82**	52.06**	19.98**	52.62**	11.76**	22.06**	-20.19**	4.54**
DPL - 21 x Garima	7.25**	10.24**	14.87**	10.79**	51.87**	24.84**	42.88**	39.88**	21.04**	-22.68**	41.79**	13.38**
DPL - 21 x KL - 43	45.72**	52.25**	26.98**	41.65**	76.54**	55.54**	38.68**	56.92**	21.68**	10.16**	23.02**	18.29**
DPL-21xLCK 88062	3.25**	-4.46**	5.59**	1.46**	43.97**	5.77**	26.75**	25.50**	11.38**	-25.11**	31.97**	6.08**
J - 23 x RLC - 6	9.46**	11.98**	27.44**	16.29**	18.60**	23.23**	41.74**	27.86**	15.86**	-12.43**	18.41**	7.28**
J - 23 x Garima	-21.63**	0.40	16.23**	-1.67**	-12.02**	25.40**	27.98**	13.79**	-14.00**	-20.17**	9.24**	-8.31**
J - 23 x KL – 43	-15.47**	5.08**	4.17**	-2.07**	-6.65**	19.93**	9.89**	7.72**	-30.64**	-36.31**	9.26**	-19.23**
J - 23 x LCK 88062	-5.19**	0.66**	14.11**	3.19**	4.01**	23.25**	20.46**	15.91**	-5.82**	-27.66**	18.99**	-4.83**
RLC 6 x Garima	-43.22**	-19.11**	17.54**	-14.93**	-31.63**	-6.79**	42.34**	1.31**	-13.56**	-30.98**	33.32**	-3.74**
RLC 6 x KL – 43	3.32**	-16.25**	7.57**	-1.79**	5.50**	-12.78**	13.77**	2.16**	-15.08**	-86.84**	10.56**	-30.45**
RLC 6 x LCK 88062	-28.87**	14.83**	12.30**	-0.58**	-16.13**	29.37**	31.03**	14.76**	2.65**	18.48**	21.05**	14.06**
Garima x KL - 43	-6.85**	0.40	-2.77**	-3.07**	14.04**	11.61**	12.32**	12.66**	32.02**	12.48**	-3.90**	13.53**
Garima x LCK 88062	6.14**	7.67**	3.60**	5.80**	8.89**	10.48**	8.33**	9.23**	50.63**	-2.76**	7.41**	18.43**
KL 43 x LCK 88062	-4.72**	-9.16**	4.79**	-3.03**	14.29**	-1.37**	16.35**	9.76**	13.12**	-29.46**	3.35**	-4.33**
S.E. ±	0.24	0.25	0.17	0.22	0.23	0.23	0.16	0.21	0.31	0.25	0.20	0.25

*** Significant at p = 0.05 ** Significant at p = 0.01**
L_1: Rath; L_2: Jabalpur; L_3: Kanpur.

Table-11 : ANOVA for stability parameters (Mean sum of squares) for parents and their 45 F_2 (Eberhart and Russel model)

Source of Variation	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Technical plant height (cm)	No. of tiller/ plant	No. of branches/ plant	No. of capsules/ plant	No. of seeds/ capsule	1000-seed weight (g)	Harvest index	Fibre yield/ plant (g.)	Oil content (%)	Seed yield/ plant (g)
Varieties/ genotypes	54	82.821**	37.326**	199.086**	362.071**	3.208**	128.631**	175.101**	0.821**	13.085**	33.432**	3.100**	2.031**	4.718**
Environments	2	515.890**	963.133**	439.311**	294.152**	24.483**	4091.840**	11610.747**	83.346**	88.123**	148.651**	1.752**	18.871**	8.636**
Genotypes/Env. (G x E)	108	22.270**	8.771**	50.667**	59.568**	0.963**	24.947**	98.103**	0.431**	12.385**	6.208**	0.195**	0.364**	0.673**
Envts. + (Genotypes) x (Environment)	110	31.232**	26.123**	57.733**	63.833**	1.390**	98.890**	307.424**	1.938**	13.762**	8.798**	0.224**	0.701**	0.817**
Environments (Linear)	1	1030.258**	1925.635**	879.07**	588.087**	48.962**	8183.771**	23221.412**	166.688**	176.227**	297.359**	3.504**	37.730**	17.272**
G x E (Linear)	54	22.651**	6.225**	26.263**	59.134**	1.143**	25.508**	61.449**	0.350**	9.133**	8.134**	0.210**	0.366**	0.642**
Pooled deviation		21.492**	11.123**	73.697**	58. 914**	0.768**	23.940**	132.308**	0.501**	15.354**	4.203**	0.177**	0.356**	0.691*
Pooled error	324	1.879**	2.285**	46.731**	11..227**	0.188**	12.837**	29.663**	0.395**	9.374**	5.662**	0.030**	0.174**	0.138**

* Significant at p = 0.05 ** Significant at p =0.01

Table12 : Estimates of stability parameters in parents and in F_2 generations in respect of 13 characters in Linseed.

Parents/Cross (Parent/F_2s)	Days to 50% flowering			Days to maturity			Plant height (cm)		
	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di
Neelum	69.22	1.34	6.61**	131.67	1.27*	12.25**	89.12	0.80	8.43
Shubhra	67.33	2.74*	3.06**	128.00	1.21*	-0.77	72.37	1.26	136.99**
Sweta	57.89	1.36	0.54	128.11	0.56	18.43**	74.82	-1.60	28.58
LMH-62	56.11	0.62	3.10**	121.78	0.73	2.89**	56.82	2.17	159.28**
DPL-21	79.67	1.17	95.72**	136.89	1.77**	0.59	90.54	2.15	-5.57
J-23	63.67	2.42*	58.97**	127.44	1.00	49.77**	78.92	0.41	17.31
RLC-6	66.11	0.92	1.88**	125.22	0.94	18.64**	69.12	-2.77	134.29**
Garima	61.67	1.68	22.77**	128.78	0.93	-0.69	71.56	-0.05	41.13**
KL-43	67.67	.71	21.07**	134.33	0.53	6.39**	85.87	-2.23	23.84
LCK-88062	67.67	2.46*	4.11**	130.89	1.05	10.42**	83.13	2.10	-15.54
Neelum x Shubhra	68.89	1.45	1.08*	129.33	1.15*	-0.62	89.81	1.21	6.35
Neelum x Sweta	62.89	0.59	6.32**	129.33	0.70	3.83**	87.78	1.51	152.72**
Neelum x LMH-62	62.11	0.25	0.30	128.33	1.25*	22.73**	84.76	0.69	200.35**
Neelum x DPL-21	71.00	1.06	27.94**	136.00	2.20**	-0.76	97.73	0.94	104.90**
Neelum x J-23	65.33	1.55	158.31**	133.78	1.69**	7.09**	89.27	1.18	-12.02
Neelum x RLC-6	70.11	1.00	7.79**	128.27	1.01	2.64**	86.21	3.06	-15.56
Neelum x Garima	64.89	1.34	16.22**	130.67	1.29**	1.44	87.15	1.57	48.27**
Neelum x KL-43	69.56	0.41	0.69	137.78	2.30**	89.05**	98.61	-0.51	41.74**
Neelum x LCK-88062	67.44	1.86	0.46	133.00	1.32*	-0.46	93.53	1.10	-13.68
Shubhra x Sweta	62.44	1.39	0.08	130.11	0.50	4.82**	77.64	0.20	267.59**
Shubhra x LMH-62	58.56	0.32	-0.43	125.56	0.61	11.72**	76.99	2.49	9.63
Shubhra x DPL-21	74.44	0.82	1.21	133.44	0.91	-0.21	84.43	2.27	207.89**
Shubhra x J-23	64.22	2.94**	15.26**	128.56	0.82	2.44**	85.44	1.94	97.68**
Shubhra x RLC-6	66.67	1.41	1.01	1.27.44	0.79	14.94**	80.54	1.79	-11.59
Shubhra x Garima	65.89	1.55	0.51	129.56	0.95	-0.47	76.18	2.07	42.86**
Shubhra x KL-43	67.89	1.28	30.34**	136.89	1.80**	48.26**	85.92	0.19	-15.56
Shubhra x LCK-88062	65.78	2.80**	-0.38	134.67	1.45**	6.23**	85.83	0.16	0.98

Table : Conted......

Sweta x LMH-62	56.11	-0.04	6.08**	127.11	0.97	0.37	76.51	0.11	-13.61
Sweta x DPL-21	75.22	-2.29*	100.73**	132.0	1.01	24.08**	94.56	1.65	27.13
Sweta x J-23	61.22	1.05	32.25**	130.11	1.22*	28.05**	83.74	-0.44	28.16
Sweta x RLC-6	63.33	0.48	1.98**	128.00	0.87	8.87**	84.18	-0.52	-15.28
Sweta x Garima	60.56	0.39	34.44**	130.00	0.70	3.83**	82.67	-0.30	0.70
Sweta x KL-43	59.89	1.06	10.78**	132.33	0.39	6.53**	90.29	-0.47	-8.02
Sweta x LCK-88062	63.78	0.90	4.16**	132.44	1.08	30.21**	88.50	1.64	-13.73
LMH-62 x DPL-21	66.78	-2.58*	-0.54	129.78	0.85	8.07**	94.57	2.02	68.92**
LMH-62 x J-23	63.11	-1.02	0.12	120.78	0.81	3.44**	82.72	0.00	-10.59
LMH-62 x RLC-6	56.78	0.43	13.83**	125.78	1.05	6.13**	73.62	-0.13	127.27**
LMH-62 x Garima	59.44	-0.24	15.30**	127.33	0.45	5.66**	74.42	0.71	-12.98
LMH-62 x KL-43	61.33	-0.36	21.85**	128.67	1.04	4.83**	86.55	-0.85	-1.76
LMH-62 x LCK-88062	57.33	1.32	-0.62	126.78	1.00	15.28**	83.54	3.43	-7.50
DPL-21 x J-23	71.56	0.60	0.66	132.56	0.94	0.56	94.93	1.97	108.88**
DPL-21 x RLC-6	74.00	0.86	11.44**	130.56	0.88	15.92**	91.02	2.90	103.27**
DPL-21 x Garima	70.78	-0.10	49.49**	133.89	0.58	-0.15	86.24	2.25	79.17**
DPL-21 x KL-43	77.56	-0.31	102.58**	138.67	1.76**	-0.75	95.86	2.18	162.04**
DPL-21 x LCK-88062	71.44	0.66	62.85**	136.89	0.44	19.13**	102.84	1.80	877.56**
J-23 x RLC-6	69.00	3.01**	0.72	127.89	0.83	-0.77	83.42	0.37	-15.19
J-23 x Garima	61.89	1.42	65.27**	130.111	1.00	9.80**	79.39	1.44	8.01
J-23 x KL-43	65.56	1.44	5.43**	132.67	1.02	18.86**	82.39	1.25	-15.25
J-23 x LCK-88062	64.00	2.72*	17.06**	129.78	1.31*	-0.61	88.77	1.27	-11.14
RLC-6 x Garima	63.67	1.88	5.59**	128.78	0.41	8.01**	77.11	0.62	29.85
RLC-6 x KL-43	68.44	1.03	41.95**	128.67	0.54	5.10**	87.05	-0.08	6.80
RLC-6 x LCK-88062	66.44	1.01	-0.62	129.00	0.70	14.00**	80.56	-0.53	54.71**
Garima x KL-43	68.11	0.74	8.44**	131.78	0.51	1.47	80.38	2.72	9.74
Garima x LCK-88062	62.67	2.24**	38.96**	131.56	1.13*	-0.35	86.04	2.05	-12.64
KL-43 x LCK-88062	68.89	1.27	12.91**	136.22	0.77	3.69**	91.29	1.42	0.77
$\bar{X}$	**65.71**	**1.00**		**130.59**	**1.00**		**84.42**	**1.00**	
SE ±	**3.28**	**1.07**		**2.36**	**0.56**		**6.07**	**2.15**	

Table : Contd.....

Parents/Cross (Parent/F_2s)	Technical plant height (cm)			No. of tillers/plant			No. of branches/plant		
	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di
Neelum	55.62	0.00	-2.29	4.44	0.72	-0.05	24.61	0.51	18.07**
Shubhra	45.07	2.34	29.48**	5.48	0.42	0.03	24.91	0.79*	-4.27
Sweta	43.05	-0.13	15.39**	5.07	0.79	3.12**	25.08	0.94*	-0.39
LMH-62	45.50	1.26	107.11**	4.30	1.02	-0.05	29.11	0.35	8.07
DPL-21	67.00	-1.24	256.74**	7.21	1.23	0.90**	24.00	0.47	-4.02
J-23	42.70	-0.68	97.00**	4.28	0.14	0.84**	24.80	0.52	34.47**
RLC-6	42.25	0.12	21.33**	4.33	0.42	-0.05	24.66	0.36	9.08*
Garima	49.82	1.16	-1.24	5.28	0.62	0.40**	23.57	0.46	9.23*
KL-43	56.36	0.60	41.09**	6.02	0.94	0.62**	21.44	0.44	8.78*
LCK-88062	61.66	0.56	47.00**	6.60	1.68	5.78**	17.81	0.73	1.84
Neelum x Shubhra	57.61	0.33	-2.44	5.88	1.12	0.05	34.40	0.97*	-4.19
Neelum x Sweta	58.07	2.36	4.88	5.46	2.00*	-0.05	38.43	1.47**	55.49**
Neelum x LMH-62	54.24	3.43	28.70**	8.08	2.04*	0.51**	38.13	0.41	-4.26
Neelum x DPL-21	56.12	13.33**	-3.76	7.12	1.98*	0.78**	29.68	0.59	3.32
Neelum x J-23	61.44	1.01	-3.74	5.18	0.18	0.78**	35.70	1.17**	-4.28
Neelum x RLC-6	58.81	0.53	16.90**	4.88	-0.24	1.02**	36.57	0.81*	220.63**
Neelum x Garima	62.63	0.23	-3.45	6.01	-0.24	0.14*	32.17	0.68	-2.31
Neelum x KL-43	70.08	0.08	533.71**	7.27	3.76**	0.44**	27.27	1.19**	37.05**
Neelum x LCK-88062	71.94	2.04	3.40	7.60	1.23	2.56**	30.71	0.93*	49.72**
Shubhra x Sweta	49.58	3.43	-2.28	5.91	-0.48	1.21**	43.48	1.37**	160.46**
Shubhra x LMH-62	52.58	2.33	49.83**	6.10	1.72	-0.04	44.74	0.94*	-1.00
Shubhra x DPL-21	67.86	5.10*	7.04	7.91	2.35*	1.07**	35.82	0.97*	72.25**
Shubhra x J-23	52.06	2.61	0.44	5.36	-0.28	1.91**	38.40	1.43**	-0.98
Shubhra x RLC-6	51.35	3.04	2.86	5.65	-0.24	0.34**	43.82	1.97**	2.77
Shubhra x Garima	55.80	1.07	18.24**	5.44	-1.68	-0.03	38.65	1.50**	41.53**
Shubhra x KL-43	59.41	-0.70	8.40*	6.24	-0.17	-0.03	33.05	1.65**	27.30**
Shubhra x LCK-88062	68.79	1.09	6.65	6.94	1.07	-0.04	26.94	1.09**	54.93**

Table : Contd......

Sweta x LMH-62	48.75	0.44	109.00**	4.79	-0.22	-0.06	44.25	1.22**	2.91
Sweta x DPL-21	78.24	-0.91	137.29**	7.21	1.02	2.48**	37.66	1.32**	-3.63
Sweta x J-23	53.66	2.19	-3.10	4.36	-0.14	0.66**	41.93	1.77**	13.02**
Sweta x RLC-6	47.05	-0.45	43.53**	5.54	1.57	0.31**	38.54	1.36**	-0.56
Sweta x Garima	54.41	0.65	56.01**	6.54	1.83*	0.78**	34.87	1.22**	-3.62
Sweta x KL-43	58.56	0.37	7.25	7.06	3.01**	0.12	33.77	1.25**	6.41
Sweta x LCK-88062	68.89	2.26	104.33**	6.89	3.77**	0.98**	27.54	1.39**	17.88**
LMH-62 x DPL-21	82.52	1.09	-2.61	6.08	-0.19	1.71**	39.99	0.83*	6.70
LMH-62 x J-23	53.39	2.63	12.38**	4.98	-0.11	0.64**	39.60	1.65**	4.15
LMH-62 x RLC-6	50.59	1.63	110.42**	5.36	1.65	0.12	42.67	0.99*	-3.10
LMH-62 x Garima	59.08	2.34	22.73**	5.75	2.17*	-0.03	40.44	0.67	9.47*
LMH-62 x KL-43	64.89	0.96	70.86**	5.81	-1.74	0.28**	36.28	0.79*	-0.83
LMH-62 x LCK-88062	72.53	-0.74	-3.40	6.80	1.30	0.48**	34.61	1.28**	30.23**
DPL-21 x J-23	77.50	-1.60	270.48**	7.37	2.12**	1.08**	36.72	1.04**	29.26**
DPL-21 x RLC-6	73.06	-1.86	195.17**	6.74	1.72	-0.03	45.03	2.06**	-1.45
DPL-21 x Garima	80.10	-1.04	76.99**	8.36	1.71	1.71**	39.67	1.05**	117.61**
DPL-21 x KL-43	83.66	-3.90	-3.53	7.70	0.75	0.12	32.83	0.75	13.96**
DPL-21 x LCK-88062	79.66	-2.92	385.43**	8.24	2.20*	1.69**	31.61	0.72	3.43
J-23 x RLC-6	53.08	2 .68	6.31	6.02	2.11*	0.07	33.44	0.85*	2.43
J-23 x Garima	57.01	2.38	-1.89	5.65	0.16	0.10	38.71	1.02*	-4.18
J-23 x KL-43	64.28	0.84	9.28*	5.34	-0.12	1.14**	36.20	1.33**	20.71**
J-23 x LCK-88062	70.06	0.71	15.12**	7.42	0.50	1.30**	33.58	0.78*	24.53**
RLC-6 x Garima	55.14	1.19	8.50*	5.93	1.80	0.04	39.02	1.55**	-4.02
RLC-6 x KL-43	66.38	1.06	6.48	5.78	0.51	0.42**	30.98	0.53	-3.98
RLC-6 x LCK-88062	70.53	0.84	62.75**	6.20	1.15	0.05	30.85	0.73	-3.45
Garima x KL-43	65.28	0.24	55.07**	6.64	1.14	0.22**	32.99	0.68	-2.11
Garima x LCK-88062	73.32	-0.42	4.41	5.75	1.67	0.30**	30.70	0.70	3.02
KL-43 x LCK-88062	76.28	-1.18	2.21	7.14	1.57	-0.06	28.10	0.81*	15.70**
$\bar{X}$	**60.97**	**1.00**		**6.09**	**1.00**		**33.83**	**1.00**	
SE ±	**5.42**	**2.35**		**0.62**	**0.93**		**3.46**	**0.40**	

Table : Contd.....

Parents/Cross (Parent/F_2s)	No. of capsules/plant			No. of seeds/plant			1000-seed weight (g)		
	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di
Neelum	62.67	1.60**	395.71**	8.03	0.15	-0.09	8.61	1.01	-1.95
Shubhra	54.70	1.55**	323.29**	7.38	1.09**	0.49**	7.25	0.26	-2.82
Sweta	57.96	0.76	4.02	6.92	0.52	-0.11	8.27	0.72	-1.93
LMH-62	67.39	0.70	65.70**	7.19	0.68	-0.09	7.36	0.66	-2.11
DPL-21	60.75	0.82	90.38**	6.81	0.59	-0.11	7.07	0.65	-2.35
J-23	59.42	1.09	299.54**	7.55	0.89*	0.03	7.32	0.81	-2.94
RLC-6	56.19	0.55	183.18**	6.97	1.10**	0.69**	6.85	6.72	-1.78
Garima	56.42	1.31*	0.23	7.23	0.96*	-0.13	7.85	1.25	-3.09
KL-43	63.49	1.23*	-8.21	7.10	0.81*	0.16	6.91	0.53	-2.86
LCK-88062	56.02	0.77	-8.81	7.65	1.23**	-0.04	7.35	0.30	-2.93
Neelum x Shubhra	69.27	1.19*	551.91**	8.10	0.50	0.25*	8.93	1.09	-2.17
Neelum x Sweta	74.09	1.17*	86.91**	8.44	0.33	0.01	9.05	1.01	-2.47
Neelum x LMH-62	81.93	0.83	-9.84	8.36	0.40	-0.13	8.63	0.86	-1.51
Neelum x DPL-21	78.69	1.15*	531.83**	8.23	0.54	0.56**	9.05	1.04	-2.08
Neelum x J-23	69.56	1.72**	145.87**	9.10	0.72	0.09	9.05	0.85	-1.54
Neelum x RLC-6	73.16	1.36*	275.46**	8.33	0.69	3.09**	9.13	1.05	-1.23
Neelum x Garima	71.88	1.45**	-7.28	8.53	0.72	0.01	9.21	1.12	-3.07
Neelum x KL-43	78.23	1.47**	-9.27	8.89	0.97*	0.00	9.06	1.70	-3.00
Neelum x LCK-88062	74.74	1.13*	56.94**	8.85	0.94*	0.01	9.25	0.81	-0.40
Shubhra x Sweta	74.28	0.99	-9.80	8.09	0.87*	0.32*	8.41	0.63	-0.61
Shubhra x LMH-62	86.66	0.68	113.04**	8.63	0.87*	2.97**	8.21	0.46	-2.10
Shubhra x DPL-21	78.10	1.16*	143.82**	7.59	1.01*	0.56**	7.83	0.31	-2.85
Shubhra x J-23	77.95	1.53**	480.43**	7.86	1.11**	-0.04	7.60	0.94	-2.05
Shubhra x RLC-6	75.26	0.98	95.43**	8.27	1.47**	-0.07	8.16	0.58	-2.85
Shubhra x Garima	74.59	0.81	114.69**	8.30	1.64**	-0.02	8.62	1.02	-3.12
Shubhra x KL-43	64.90	1.35*	73.49**	8.36	1.59**	0.16	7.53	0.43	-2.93
Shubhra x LCK-88062	64.68	1.39*	55.62**	8.40	1.64**	-0.09	8.33	-0.11	-3.11

Table : Contd……

Sweta x LMH-62	79.05	0.75	163.82**	7.82	0.64	-0.06	8.58	0.57	-1.96
Sweta x DPL-21	73.03	0.12	-3.42	7.63	0.98*	-0.11	8.47	0.79	-1.59
Sweta x J-23	73.16	1.32*	-9.58	7.97	0.59	-0.13	9.07	0.63	-2.94
Sweta x RLC-6	65.07	0.58	9.12	8.08	1.15**	-0.07	8.68	0.80	-2.67
Sweta x Garima	74.37	1.38*	2.15	8.40	0.84*	-0.13	8.90	0.98	-2.81
Sweta x KL-43	82.26	0.45	53.39**	8.22	0.99*	3.54**	9.39	1.04	-3.12
Sweta x LCK-88062	77.15	0.10	-6.80	8.14	0.84*	1.86**	8.71	0.40	-1.69
LMH-62 x DPL-21	71.42	0.86	52.00**	7.72	1.04*	-0.08	8.41	0.55	-2.10
LMH-62 x J-23	87.24	1.24*	64.36**	8.91	1.00*	0.59**	8.21	0.61	-1.58
LMH-62 x RLC-6	73.03	0.14	617.27**	8.11	0.97*	0.60**	8.32	1.02	-1.76
LMH-62 x Garima	84.20	1.09*	2.45	8.41	1.13**	0.09	9.18	1.19	-2.59
LMH-62 x KL-43	79.27	0.93	250.03**	7.96	0.90*	0.38**	8.75	1.37	-2.70
LMH-62 x LCK-88062	78.23	0.97	17.53	8.40	0.96*	0.04	8.69	0.51	-2.93
DPL-21 x J-23	74.44	0.76	-0.66	8.36	1.56**	0.87**	8.03	0.81	-1.46
DPL-21 x RLC-6	73.81	1.19*	331.63**	7.93	1.33**	-0.11	8.06	0.64	-2.90
DPL-21 x Garima	73.72	0.84	15.42	7.99	1.13**	-0.12	8.91	1.17	-3.01
DPL-21 x KL-43	71.63	1.17**	13.99	7.97	1.29**	-0.13	8.15	0.80	-3.00
DPL-21 x LCK-88062	69.99	1.00	-4.97	8.36	1.17**	0.07	8.37	0.45	-2.27
J-23 x RLC-6	75.83	0.86	77.34**	7.74	0.94*	0.76**	7.98	0.76	-2.50
J-23 x Garima	71.22	1.30*	1.08	8.24	1.18**	-0.11	8.18	1.11	-3.12
J-23 x KL-43	70.80	1.15*	48.75**	7.41	1.03*	0.36**	7.70	4.35*	267.77**
J-23 x LCK-88062	73.04	0.93	-9.85	8.86	1.36**	0.78**	8.41	0.20	-2.70
RLC-6 x Garima	67.64	0.52	267.45**	7.91	1.28**	0.19	8.91	1.13	-2.17
RLC-6 x KL-43	76.28	0.99	397.61**	7.47	1.20**	1.22**	8.26	1.10	-3.12
RLC-6 x LCK-88062	73.67	0.22	153.14**	8.13	1.25**	0.40**	8.11	0.39	-3.01
Garima x KL-43	71.14	1.48**	71.30**	7.99	1.18**	0.53**	8.59	0.95	-3.03
Garima x LCK-88062	65.84	0.73	55.65**	8.29	1.44**	0.04	9.13	0.81	-2.99
KL-43 x LCK-88062	71.17	1.09	67.87**	8.60	1.56**	0.58**	8.01	0.45	-3.12
$\bar{X}$	**71.65**	**1.00**		**8.04**	**1.00**		**8.63**	**1.00**	
SE ±	**8.13**	**0.56**		**0.50**	**0.41**		**2.77**	**2.19**	

Table : Contd.....

Parents/Cross (Parent/F_2s)	Harvest index (%)			Fibre yield/plant (g)		
	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di
Neelum	30.87	0.67	-0.74	2.47	1.06	-0.01
Shubhra	31.25	3.57**	0.52	1.26	2.39	0.02
Sweta	27.21	-0.30	-1.21	0.90	-0.43	0.01
LMH-62	24.46	2.40**	1.62	1.02	-0.64	-0.01
DPL-21	26.11	1.31	-1.88	3.56	2.50	0.25**
J-23	28.55	3.90**	6.91**	1.67	1.25	0.05**
RLC-6	25.69	1.94*	-1.50	1.11	-1.10	-0.01
Garima	33.23	0.05	6.54**	1.18	-0.08	0.05**
KL-43	26.41	-0.54	1.87	2.76	-1.42	0.02
LCK-88062	31.02	0.58	-0.86	3.09	0.99	0.02
Neelum x Shubhra	36.46	2.83**	-1.41	2.66	0.57	0.02
Neelum x Sweta	34.77	0.75	2.14	2.65	1.10	0.03*
Neelum x LMH-62	37.98	1.13	10.32**	2.15	1.62	0.85**
Neelum x DPL-21	33.50	1.16	9.39**	4.01	1.77	0.01
Neelum x J-23	35.54	0.62	-1.87	2.60	1.12	0.00
Neelum x RLC-6	33.74	0.92	2.11	2.52	2.51	-0.01
Neelum x Garima	37.26	0.08	2.14	2.68	0.98	0.12**
Neelum x KL-43	33.49	1.00	4.47*	3.74	-5.10**	0.06**
Neelum x LCK-88062	36.41	0.51	-0.78	3.97	1.41	0.24**
Shubhra x Sweta	35.75	1.46	16.32**	1.90	4.79**	0.43**
Shubhra x LMH-62	39.66	1.28	-1.85	1.57	1.48	0.16**
Shubhra x DPL-21	33.16	3.38**	0.82	4.34	1.56	0.20**
Shubhra x J-23	34.62	2.19**	5.57**	2.00	2.71	0.19**
Shubhra x RLC-6	33.00	3.82**	-1.83	1.72	0.80	0.25**
Shubhra x Garima	37.08	-0.19	8.06**	1.67	1.91	0.18**
Shubhra x KL-43	34.85	1.10	2.72	2.83	3.40*	1.64**
Shubhra x LCK-88062	37.37	1.90*	-0.78	3.74	1.94	0.08**

Table : Contd......

Sweta x LMH-62	39.60	-0.17	-1.08	1.35	-1.79	0.07**
Sweta x DPL-21	31.59	0.91	5.58**	4.03	2.45	-0.01
Sweta x J-23	32.11	-0.78	-1.76	2.14	3.85*	0.26**
Sweta x RLC-6	31.76	-0.32	5.68**	1.34	-1.31	-0.01
Sweta x Garima	35.90	-0.88	1.98	1.45	0.53	0.08**
Sweta x KL-43	30.75	-0.56	2.00	2.50	2.56	0.38**
Sweta x LCK-88062	35.19	-0.03	-1.88	3.54	1.72	0.08**
LMH-62 x DPL-21	37.52	1.33	9.63**	4.09	0.33	0.02
LMH-62 x J-23	38.59	0.37	-0.08	1.99	0.70	0.23**
LMH-62 x RLC-6	38.92	1.34	0.21	1.48	-1.78	0.00
LMH-62 x Garima	38.51	0.45	-1.87	1.66	-1.41	0.42**
LMH-62 x KL-43	36.58	1.18	1.56	3.23	-2.32	0.12**
LMH-62 x LCK-88062	37.32	1.33	6.57**	3.52	0.70	0.01
DPL-21 x J-23	31.50	3.32**	1.29	4.17	3.34*	0.35**
DPL-21 x RLC-6	30.14	-0.56	13.96**	3.67	3.40*	0.48**
DPL-21 x Garima	36.02	-1.47	6.40**	3.97	3.43*	0.17**
DPL-21 x KL-43	32.23	1.14	-0.23	3.96	0.18	0.00
DPL-21 x LCK-88062	33.39	0.68	-1.14	4.13	3.67*	0.32**
J-23 x RLC-6	32.16	3.39**	-1.59	2.04	2.05	0.17**
J-23 x Garima	35.49	0.58	10.54**	1.99	1.18	0.23**
J-23 x KL-43	32.79	1.49	-1.44	3.33	-1.01	0.13**
J-23 x LCK-88062	35.29	0.39	-1.53	3.52	1.63	0.33*
RLC-6 x Garima	35.80	0.55	6.48**	1.58	0.33	0.13**
RLC-6 x KL-43	31.56	1.55	-1.35	3.27	-0.87	0.03*
RLC-6 x LCK-88062	33.73	-0.30	-1.16	3.47	0.84	0.08**
Garima x KL-43	34.69	-0.14	3.30	3.16	-0.67	-0.01
Garima x LCK-88062	35.88	0.33	0.37	3.19	1.81	0.23**
KL-43 x LCK-88062	32.20	0.77	0.15	3.64	2.27	0.00
$\bar{X}$	**33.92**	**1.00**		**2.676**	**1.00**	
SE ±	**1.45**	**0.88**		**0.30**	**1.67**	

Table : Contd.....

Parents/Cross (Parent/F_2s)	Oil content (%)			Seed yield/plant (g)		
	$\bar{X}$	bi	S^2di	$\bar{X}$	bi	S^2di
Neelum	40.94	1.15	-0.05	5.18	1.10	0.16**
Shubhra	43.07	1.23	0.26**	4.69	2.10	2.82**
Sweta	43.11	-0.23	0.03	4.29	-3.03*	2.44**
LMH-62	43.78	2.08**	0.02	7.89	1.02	-0.01
DPL-21	42.01	1.06	1.29**	3.90	-1.35	0.46**
J-23	40.76	-0.89	-0.05	4.97	3.22*	-0.05
RLC-6	43.16	0.28	-0.02	4.56	0.65	0.04
Garima	41.94	0.29	0.47**	6.71	1.99	0.05
KL-43	42.84	0.73	-0.04	4.80	0.27	0.01
LCK-88062	41.84	1.47*	0.06	6.29	1.74	0.19**
Neelum x Shubhra	43.36	0.83	0.25**	6.19	2.27	-0.01
Neelum x Sweta	43.64	-0.03	0.35**	6.18	-0.11	0.32**
Neelum x LMH-62	44.39	1.80*	0.11*	9.08	-1.88	1.03**
Neelum x DPL-21	42.51	0.66	1.98**	5.80	0.38	1.00**
Neelum x J-23	42.12	0.20	0.30**	6.21	0.58	0.38**
Neelum x RLC-6	43.77	0.70	0.20**	6.78	2.86	0.03
Neelum x Garima	42.91	1.0	0.19**	6.86	0.87	0.39**
Neelum x KL-43	43.10	1.73*	-0.06	5.75	-0.31	0.20**
Neelm x LCK-88062	42.70	1.06	0.19**	6.85	1.67	-0.04
Shubhra x Sweta	44.27	0.53	-0.06	6.28	-0.61	2.47**
Shubhra x LMH-62	44.44	2.09**	0.30	8.74	0.86	0.44**
Shubhra x DPL-21	43.23	1.75*	0.15**	5.84	0.88	2.23**
Shubhra x J-23	42.82	-0.09	0.07	6.41	3.08*	3.43**
Shubhra x RLC-6	44.22	-0.41	0.22**	6.75	2.09	1.42**
Shubhra x Garima	43.22	0.84	0.38**	7.12	1.19	0.07
Shubhra x KL-43	43.96	1.00	0.19**	5.77	0.20	0.59**
Shubhra x LCK-88062	42.67	2.19**	0.61**	6.52	2.89	0.00

Table: Contd......

Sweta x LMH-62	44.72	0.54	-0.06	8.75	2.33	0.45**
Sweta x DPL-21	43.74	2.07**	0.75**	5.43	-1.62	3.37**
Sweta x J-23	43.60	1.09	0.61**	6.43	-1.02	0.20**
Sweta x RLC-6	43.83	0.69	0.21**	5.84	-1.84	0.75**
Sweta x Garima	43.19	0.75	-0.01	7.24	0.43	0.04
Sweta x KL-43	43.74	-0.40	-0.06	5.47	1.01	0.50**
Sweta x LCK-88062	43.17	1.93**	2.68**	7.65	0.85	0.13**
LMH-62 x DPL-21	44.43	2.09**	-0.01	8.91	3.38**	1.42**
LMH-62 x J-23	43.60	0.97	0.54**	8.56	0.39	1.17**
LMH-62 x RLC-6	44.10	1.55*	0.00	8.86	1.44	0.17**
LMH-62 x Garima	44.03	1.26	0.17**	8.93	0.59	0.03
LMH-62 x KL-43	43.87	2.18**	0.05	7.91	2.59	0.12**
LMH-62 x LCK-88062	44.25	1.04	0.06	8.74	0.81	1.17**
DPL-21 x J-23	42.71	0.67	1.45**	6.62	2.99*	0.28**
DPL-21 x RLC-6	44.22	0.82	1.12**	6.14	-0.72	1.17**
DPL-21 x Garima	43.16	1.13	0.38**	7.23	1.97	0.09*
DPL-21 x KL-43	43.58	1.27	-0.01	5.58	0.28	0.93**
DPL-21 x LCK-88062	43.00	1.89**	0.29**	6.69	0.54	0.02
J-23 x RLC-6	43.92	0.91	0.11*	6.75	2.03	-0.05
J-23 x Garima	42.78	1.26	0.26**	7.42	2.55	-0.04
J-23 x KL-43	43.67	0.39	0.02	6.30	1.85	1.19**
J-23 x LCK-88062	43.02	1.54*	-0.06	7.25	1.99	0.39**
RLC-6 x Garima	43.96	0.19	0.16**	7.71	0.91	0.01
RLC-6 x KL-43	44.17	0.85	0.02	5.93	1.44	0.13**
RLC-6 x LCK-88062	43.29	1.47*	-0.06	7.03	0.88	0.01
Garima x KL-43	43.45	0.91	0.10	7.03	1.47	0.69**
Garima x LCK-88062	43.29	0.74	0.18**	7.02	-0.17	-0.02
KL-43 x LCK-88062	43.19	2.19**	0.18**	6.38	2.47	0.11*
$\bar{X}$	**43.32**	**1.00**		**6.66**	**1.00**	
SE ±	**0.42**	**0.72**		**0.59**	**1.48**	

* Significant at p = 0.05   ** Significant at p = 0..01

Table 13 : **Estimates of heritability (NS) in percent for 13 characters in a 10-parent diallel crosses of F_1 and F_2 generations at different locations and pooled over locations in linseed.**

Characters	F_1				F_2			
	L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Days to 50% flowering	49.11	44.60	54.62	66.40	49.05	74.39	46.02	81.96
Days to maturity	69.82	54.33	36.52	61.88	22.25	1.11	26.64	13.21
Plant height (cm)	74.51	77.94	17.61	61.61	54.93	135.48	47.12	93.16
Technical plant height (cm.)	35.02	11.80	16.72	23.33	78.44	20.09	50.30	66.73
No. of tillers / plant	21.26	44.08	17.93	35.41	36.18	7.15	17.88	19.07
No. of branches/plant	2.42	3.31	13.63	5.52	5.63	6.79	27.10	15.22
No. of capsules/plant	22.90	20.61	7.56	7.08	51.45	34.24	20.34	24.19
No. of seeds/capsule	14.07	29.25	11.31	20.82	31.89	81.66	41.56	57.64
1000 seed weight (g)	52.06	17.63	34.96	33.41	83.00	20.71	29.41	60.03
Harvest index (%)	41.24	24.00	30.05	31.63	62.71	38.87	14.55	47.46
Fibre yield/plant (g)	39.52	31.70	29.56	37.11	53.74	45.59	67.00	78.02
Oil content (%)	68.91	38.37	33.30	58.02	51.50	45.76	47.27	73.07
Seed yield/ plant (g.)	53.84	29.74	25.08	39.76	68.40	78.52	56.86	92.92

L_1: Rath; L_2: Jabalpur; L_3 : Kanpur

Table – 14 : Estimates to genetic advance and genetic advance in percent of mean for 13 characters in 10-parant diallel crosses of F_1 and F_2 generations at different locations and pooled over locations in linseed.

Characters	Gen.	Genetic advance				Genetic advance in percent of mean			
		L_1	L_2	L_3	Pooled	L_1	L_2	L_3	Pooled
Days to 50% flowering	F_1	14.60	6.80	12.28	21.43	22.75	10.60	32.6	32.62
	F_2	14.32	9.19	10.02	23.75	22.34	14.72	13.50	35.49
Days to maturity	F_1	10.24	6.04	6.92	13.51	7.74	4.79	5.16	10.33
	F_2	5.46	0.42	6.24	5.16	3.91	0.32	4.45	3.77
Plant height (cm)	F_1	24.98	22.82	7.76	31.01	27.97	27.61	9.02	36.05
	F_2	20.52	35.12	13.72	40.39	27.07	44.90	18.10	52.71
Technical plant height (Cm.)	F_1	16.09	4.00	9.16	15.37	24.61	6.25	15.19	24.32
	F_2	23.78	4.71	15.48	27.69	43.98	8.17	30.31	51.01
No. of tillers /plant	F_1	1.26	1.67	0.69	2.24	17.99	29.61	11.29	35.65
	F_2	1.70	0.48	5.03	1.11	28.71	9.12	9.80	20.36
No. of branches/plant	F_1	0.73	1.09	2.30	2.23	1.72	2.85	8.96	6.18
	F_2	1.03	1.46	3.14	3.53	2.88	4.78	15.51	12.23
No. of capsules/ plant	F_1	8.45	10.31	23.49	3.35	9.48	14.02	38.91	4.51
	F_2	13.89	13.69	3.73	6.40	18.23	21.22	7.34	10.01
No. of seeds/capsule	F_1	3.81	0.69	0.04	0.36	4.09	10.06	0.45	4.33
	F_2	0.58	1.13	7.47	1.02	6.96	18.16	9.63	13.63
1000 seed weight (g)	F_1	1.67	0.38	1.08	0.44	17.76	5.13	10.72	4.96
	F_2	2.17	0.38	7.54	1.66	27.28	5.64	9.42	21.76
Harvest index (%)	F_1	5.38	3.69	4.00	6.60	15.01	3.02	11.13	18.90
	F_2	6.37	4.58	2.02	7.40	19.95	16.12	6.47	24.22
Fibre yield/plant (g)	F_1	1.53	1.03	1.33	2.32	49.86	38.10	47.10	81.57
	F_2	2.09	1.23	2.26	4.04	62.71	59.33	46.74	89.07
Oil content (%)	F_1	2.40	1.19	1.20	2.95	5.46	2.79	2.71	6.78
	F_2	1.79	1.32	1.55	3.28	4.17	3.14	3.66	7.74
Seed yield/plant (g.)	F_1	3.11	1.36	1.20	3.10	42.82	20.78	17.01	44.61
	F_2	3.56	2.33	1.83	4.90	63.02	42.70	30.73	86.19

L_1: Rath ; L_2: Jabalpur; L_3 Kanpur

Table-15 Comparative evaluation of the results of gene action and average degree of dominance in a 10 parent diallel set for 13 traits in F_1 and F_2 generations in linseed.

Characters	Location	Variance components analysis						Combining ability analysis				$(\hat{H}_1/\hat{D})^{½}$	
		$\hat{D}$		$\hat{H}_1$		$\hat{H}_2$		σ^2gca		σ^2sca			
		F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Days to 50% flowering	L_1	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	PD	OD
	L_2	HS	HS	HS	S	HS	S	HS	HS	HS	HS	OD	OD
	L_3	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	PD	OD
Days to maturity	L_1	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	PD	OD
	L_2	HS	NS	HS	NS	HS	NS	HS	HS	HS	HS	PD	OD
	L_3	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
Plant height (cm.)	L_1	HS	HS	HS	S	HS	HS	HS	HS	HS	S	PD	OD
	L_2	HS	HS	HS	HS	NS	HS	HS	HS	HS	S	PD	PD
	L_3	S	HS	S	HS	HS	HS	HS	HS	HS	HS	OD	OD
Technical plant height (cm.)	L_1	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_2	NS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_3	NS	HS	S	NS	S	S	HS	HS	HS	HS	OD	OD
No. of tillers / plant	L_1	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_2	HS	NS	HS	NS	HS	NS	HS	HS	HS	HS	OD	OD
	L_3	S	NS	HS	NS	HS	NS	HS	HS	HS	HS	OD	OD

Table Contd…..

No. of branches / plant	L_1	NS	NS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_2	NS	NS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_3	HS	HS	HS	NS	HS	NS	HS	HS	S	HS	OD	OD
No. of capsules / plant	L_1	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_2	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_3	S	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
No. of seeds/ capsule	L_1	S	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_2	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_3	NS	HS	S	HS	HS	HS	HS	HS	S	HS	OD	OD
1000 seed weight (g)	L_1	HS	HS	HS	HS	NS	HS	HS	HS	HS	HS	OD	OD
	L_2	HS	S	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_3	NS	S	NS	S	NS	S	HS	HS	HS	HS	OD	OD
Harvest index %	L_1	HS	HS	HS	HS	HS	HS	HS	HS	HS	S	CD	OD
	L_2	HS	HS	HS	S	HS	HS	HS	HS	HS	S	OD	OD
	L_3	HS	NS	HS	NS	HS	NS	HS	HS	HS	S	OD	OD
Fibre yield / plant (g)	L_1	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_2	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_3	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
Oil content (%)	L_1	HS	HS	HS	S	HS	S	HS	HS	HS	HS	OD	OD
	L_2	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_3	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
Seed yield / plant (g)	L_1	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_2	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD
	L_3	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	OD	OD

S = Significant, HS = Highly Significant, NS = Non Significant, OD = Over Dominance, PD = Partial Dominance, ND = No Dominance, CD = Complete Dominance, L_1 = Rath, L_2 = Jabalpur, L_3 = Kanpur

Table-16: Ranking of desirable parents for per se performance and GCA effects on pooled basis for 13 traits in F_1 and F_2 generation of a 10-parents diallel crosses in linseed

Characters	Best *per se* performance	Best general combiners		Best common parents
		F_1	F_2	
Days to 50% flowering	LMH-62, Sweta, Garima	LMH-62, Sweta, Garima	LMH-62, Sweta, Garima	LMH-62, Sweta, Garima
Days to maturity	LMH-62, RLC-6, J-23	LMH-62, RLC-6	LMH-62, RLC-6, Garima	LMH-62, RLC-6
Plant height (cm)	LMH-62, RLC-6, Garima, Shubhra	LMH-62, Garima, RLC-6 Shubhra	LMH-62, RLC-6, Garima, Shubhra	LMH-62, RLC-6, Garima, Shubhra
Technical plant height (cm)	DPL-21, LCK-88062, KL-43, Neelum	DPL-21, LCK-88062, KL-43	DPL-21, LCK-88062, KL-43	DPL-21, LCK-88062, KL-43
No. of tillers/plant	DPL-21, LCK-88062, KL-43, Shubhra, Garima	DPL-21, LCK-88062, KL-43	DPL-21, LCK-88062, KL-43, Shubhra	DPL-21, LCK-88062, KL-43
No. of branches/plant	LMH-62, Sweta, Shubhra, J-23	LMH-62, Sweta, RLC-6, Shubhra	RLC-6, J-23, Shubhra, Sweta	LMH-62, Sweta, Shubhra
No. of capsules/plant	LMH-62, KL-43, Neelum, DPL-21, J-3	LMH-62	LMH-62, KL-43, DPL-21	LMH-62
No. of seeds/capsules	Neelum, LCK-88062, J-23, Shubhra, Garima	Neelum, LCK-88062	Neelum, J-23, LCK-88062	Neelum, LCK-88062
1000-seed weight (g)	Neelum, Sweta, Garima, LMH-62,LCK-88062, J-23	KL-43, J-23, Neelum	Neelum, Sweta, Garima, LMH-62, J-23	Neelum, J-23
Harvest index (%)	LMH-62, Garima, Shubhra, LCK-88062, Neelum	LMH-62, Garima, Shubhra, Neelum	LMH-62, Garima, LCK-88062, Shubhra, Neelum	LMH-62, Garima, Shubhra Neelam
Fibre yield/plant (g.)	DPL-21, LCK-88062, KL-43, Neelum, J-23	DPL-21, LCK-88062, KL-43, Neelum	DPL-21, LCK-88062, KL-43, Neelum	DPL-21,LCK-88062, KL-43, Neelam
Oil content (%)	LMH-62, RLC-6, Sweta, Shubhra, KL-43	LMH-62, RLC-6, Sweta, KL-43, Shubhra	LMH-62, RLC-6, Sweta, Shubhra, KL-43	LMH-62, RLC-6, Sweta,Shubhra, KL-43
Seed yield/plant (g)	LMH-62, Garima, LCK-88062, Neelum,J-23	LMH-62, Garima, LCK-88062	LMH-62, Garima, LCK-88062, J-23	LMH-62, Garima, LCK-88062

Table – 17(a) : Ranking of desirable specific combinations for seed yield/plant on the basis *per se* performance, SCA effects, GCA effects and their performance in other traits.

Desirable cross (F_1)	*Per se* Perfor mance	SCA effect	GCA effects		Name of the traits for which cross also exhibited desirable and significant sca effects
			P_1	P_2	
Neelum × LMH 62	9.08	0.93**	-0.26**	1.75**	No. of tillers (0.43) no. of capsules per plant (3.91), oil content (0.84), technical plant height (-2.60), fibre yield (-0.20).
LMH62 × Garima	8.93	-0.04	1.75**	0.56**	No. of tillers per plant (0.28), no. of branches (2.52), no. of capsules per plant (8.64)
LMH62 × DPL-21	8.91	1.10**	1.75**	-0.60**	Harvest index (2.05), oil content (0.53)
LMH62 × RLC6	8.86	0.64**	1.75**	-0.19**	Days to 50% flowering (-3.84), no. of tillers per plant (0.38), no of branches per plant (3.43) harvest index (3.37), fibre yield (-0.16)
Sweta × LMH62	8.75	0.79**	-0.45**	1.75**	No. of branches per plant (4.97), harvest index (3.33), oil content (0.36), technical plant height (-3.01), fibre yield per plant (-0.23)
Shubhra × LMH62	8.74	0.69**	-0.36**	1.75**	Days to 50% flowering (-1.96), no. of tillers per plant (0.65), no of branches per plant (5.60), no. of capsules per plant (10.46), no. of seeds per capsule (6.58). harvest index (1.43), fibre yield / plant (-0.20)
LMH62 × LCK88062	8.74	0.04	1.75**	0.29**	Days to 50% flowering (-2.65), days to maturity (-1.21), technical plant height (6.27), no. of tillers per plant (0.53), fibre yield per plant (0.59), oil content (0.55) no. of capsules per plant (9.63) no of seeds per capsule (0.75), harvest index (1.96).
LMH62 × J-23	8.56	0.26*	1.75**	-0.11**	No. of capsules per plant (9.63) no. of seeds per capsules (0.75), harvest index (1.96).
LMH62 × KL-43	7.91	0.13	1.75**	-0.63	Days to maturity (-1.01)
RLC6 × Garima	7.71	0.68**	-0.19**	0.56**	Days to 50% flowering (-0.90), no. of tillers per plant (0.39), no. of branches per plant (3.49) harvest index (1.97), oil content (0.42), fibre yield (-0.11)
Sweta × LCK88062	7.65	1.15**	-0.45**	0.29**	No. of tillers per plant (0.29), no. of capsules per plant (7.78).

Table Contd….

Desirable cross (F_2)	*Per se* Performance	SCA effect	GCA effects		Name of the traits for which cross also exhibited desirable and significant sca effects
			P_1	P_2	
LMH62×Garima	7.36	0.01	1.05**	0.67**	No. of capsules per plant (5.54), 1000 seed weight (0.65)
LMH62×LCK88062	7.11	0.08	1.05**	0.36**	No. of branches per plant (2.31), no. of capsules per plant (3.36), 1000 seed wt. (0.21)
LMH62×RLC-6	6.81	0.20*	1.05**	-0.06**	Harvest index (3.09)
J-23×Garima	6.69	0.35**	0.04*	0.67**	--------
Garima×LCK88062	6.64	-0.01	0.67**	0.36**	Days to 50% flowering (-1.8), 1000 seed wt. (0.18), fibre yield per plant (-0.39), oil content (0.69).
Garima×KL-43	6.63	0.69**	0.67**	-0.36**	No. of capsules per plant (2.60), no. of seeds per capsules (0.17), harvest index (2.14), fibre yield per plant (-0.09)
LMH62×J-23	6.43	0.29**	1.05**	0.04*	No. of branches per plant (3.61), no. of capsules per plant (3.24), no. seeds per capsules (0.22).
LMH62×DPL-21	6.39	0.40**	1.05**	-0.68**	Plant height (-3.42), 1000 seed weight (0.14).
Neelum×Garima	6.32	0.13	-0.10**	0.67**	Days to 50% flowering (-1.16), no. of capsules per plant (4.35), fibre yield per plant (-0.19)
Neelum×LCK88062	6.27	0.40**	-0.10**	0.36**	No. of seeds/capsules (0.16)
Shubhra×Garima	6.28	0.39**	-0.40**	0.67**	No. of seeds per capsules (0.19)

*** Significant at p = 0.05 ** Significant at p = 0.01**

Table – 17(b) : Ranking of desirable specific combinations for fibre yield/plant on the basis *per se* performance, sca effect, gca effects and their performance in other traits.

Desirable cross (F_1)	*Per se* Performance	SCA effect	GCA effects		Name of the traits for which cross also exhibited desirable and significant sca effects
			P_1	P_2	
Shubhra × DPL-21	4.34	0.87**	-0.37**	1.17**	No. of tillers per plant (0.70), no. of capsules per plant (7.68).
DPL-21 × J-23	4.17	0.52**	1.17**	-0.19**	Technical plant height (8.25), no. of tillers per plant (0.66), no. of seeds per capsules (0.48), seed yield per plant (0.67).
LMH62 × DPL-21	4.09	0.77**	-0.53**	1.17**	Plant height (9.04), tech. Plant height (13.4), harvest index (2.05), oil content (0.53), seed yield per plant (1.10)
Sweta × DPL-21	4.03	0.74**	-0.56**	1.17**	Days to maturity (-128), tech. plant height (11.21), oil content (0.28).
Neelum × DPL-21	4.01	-0.04	0.21**	1.17**	Days to 50% flowering (-3.64), no. of capsules per plant (6.46)
Neelum × LCK88062	3.97	0.30**	0.21**	0.79**	Tech. plant height (2.95), no. of tillers per plant (1.00), no. of branches per plant (3.69), no. of capsules per plant (4.66), harvest index (1.45).
DPL21 × Garima	3.97	0.60**	1.17**	-0.48**	Tech. plant height (8.15), no. of tillers per plant (1.12), no. of branches per plant (5.24), no. of capsules per plant (3.95), harvest index (2.25), seed yield per plant (0.61).
Neelum × KL-43	3.74	0.38**	0.21**	0.48**	Plant height (5.37), tech. plant height (5.58), no of tillers per plant (1.10) no. of capsules per plant (5.48), no of seeds per capsules (0.59)
Shubhra× LCK88062	3.74	0.65**	-0.37**	0.79**	

Table Contd...

Desirable cross (F_2)	*Per se* Performance	SCA effect	GCA effects		Name of the traits for which cross also exhibited desirable and significant sca effects
			P_1	P_2	
DPL 21 × LCK88062	3.59	0.43**	0.77**	0.51**	Plant height (5.37), no. of seeds per capsule (0.23)
DPL-21 × KL-43	3. 23	0.17**	0.77**	0.41**	Technical plant height (6.58), no. of branches per plant (3.46)
KL-43 × LCK88062	2.94	0.21**	0.41**	0.51**	-
Neelum × DPL-21	2.94	0.07	0.22**	0.77**	Day to 50% flowering (-3.38)
Neelum × KL-43	2.87	0.35**	0.22**	0.41**	Technical plant height (4.67)
Neelum×LCK88062	2.65	0.03	0.22**	0.51**	Technical plant height (4.44), no. of seeds per capsules (0.16) seed yield per plant (0.40)
DPL-21 × Garima	2.51	0.18**	0.77**	-0.33**	-
DPL-21 × J-23	2.47	-0.09**	0.77**	-0.07**	No. of seeds per capsules (0.28), seed yield per plant (0.35)
LMH62 × DPL-21	2.43	0.09**	-0.31**	0.77**	1000 seed weight (0.14), seed yield per plant (0.40)
Shubhra× LCK88062	2.32	0.21**	-0.28	0.51**	-
J23 × KL-43	2.21	0.01	-0.07**	0.41**	Days to 50% flowering, 1000 seed weight (0.52), seed yield per plant (0.29)

*** Significant at p = 0.05   ** Significant at p = 0.01**

Table- 18(a) : Ranking of most heterotic cross, their sca effect, gca pattern and inbreeding depression on the basis of superior parent value (pooled basis)

Most heterotic crosses		Sweta/ DPL-21	Shubhra /Sweta	Sweta/ KL-43	Shubhra/ RLC-6	DPL-21 /KL-43	DPL-21 /RLC-6	Sweta/ LCK-88062	Sweta/ J-23	Neelam/ RLC-6	Sweta/ RLC-6	DPL-21 /J-23
Superior Parent value		4.29	4.69	4.80	4.69	4.80	4.56	6.29	4.97	5.18	4.56	4.97
Superior Parent heterosis		68.75**	65.41**	51.23**	45.49**	41.65**	38.65**	37.77**	33.98**	30.78**	27.95**	25.68**
Inbreeding depression		15.90**	31.58**	22.66**	18.37**	18.29**	4.54**	24.56**	10.58**	22.63**	4.00**	30.35**
sca effect	F_1	-0.18	0.42**	-0.12	0.64**	0.15	0.27**	1.15**	0.22	0.58**	-0.17	0.67**
	F_2	0.31**	0.00	-0.06	0.19**	0.01	1.03**	0.27**	0.13	0.32**	0.07	0.35**
sca effect in other traits	F_1	II,IV,XI, XII	VI,VII,X ,XI,XII	I,V,VII, VIII	VI,VII,VIII, XII	IV,X, XII	IV,VI,VII, XI,XII	IV,V,VII,X I	I,VI,VII	IV,VI,XI, XII	VIII	IV, V, VIII,XI
	F_2	VIII	VI,VIII, XI,XII	I,VII,IX	III,VI,VII,XI	IV,VI,XI	I,VI,VIII, X	---	----	XI,XII,	XI	VIII
gca effect based	P_1	-0.45**	-0.36**	-045**	-0.36**	-0.60**	-0.60**	-0.45**	-0.36**	-0.26**	-0.45**	-0.60**
on F_1	P_2	-0.60**	-0.45**	-0.63**	-0.19**	-0.63**	-0.19**	0.29**	-0.11**	-0.19**	-0.19**	-0.11**
gca effect based	P_1	-0.54	-0.40**	-0.54**	-0.40**	0.68**	0.68**	-0.54**	-0.40**	-0.10**	-0.54**	-0.68**
on F_2	P_2	-0.68	-0.54**	-0.36**	-0.06**	-0.36**	-0.06**	0.36**	0.04	-0.06**	-0.06**	0.04**
Desirable heterotic performance in other traits		V,VI,VII, VIII,IX,X,X II	IV,V,VI, VII, VIII,X,X I, XII	VI,VII, VIII, IX,X,	IV,VI,VII, VIII,IX,X, XI	I,IV,VI, VIII,X,IX, XII	IV,VI, VIII,XI, XII,IX,X	VI,VII, VIII, X,XII	IV,V,VI, VII,VIII, IX ,X,XI,XII	V,VI, VIII,IX,X, XI,XII	IV,V,VI, VII,VIII, IX, X, XI	IV,VI, VII, VIII,IX, X, XI,XII

Note: I- Days to 50% flowering; II- Days to maturity; III- Plant height (cm.), IV, Tech. Plant height (Cm.); V- No. of tillers/plant; Vi- No. of branches/ plant; VII- No. of capsules/plant; VIII-No. of seeds/capsules XI- Fibre yield /plant (g.) XII-oil content (%)*Significant at $p = 0.05$ **Significant at $p = 0.01$

Table- 18(b) : Ranking of most heterotic crosses, their sca effects, gca pattern and inbreeding depression on the basis of mid parent value (pooled basis) in linseed.

Most heterotic crosses with rank	Shubhra/ Sweta	Sweta/ KL-43	Sweta/ LCK-88062	Shubhra/ RLC-6	DPL-21/ KL-43	DPL-21/ RLC-6	Sweta/ RLC-6	DPL-21/ J-23	Sweta / DPL-21	Shubhra/ LCK-88062	Shubhra/ J-23	Sweta/ Garima
Mid Parent value	4.49	4.55	5.29	4.63	4.35	4.23	4.42	4.43	4.10	-5.49	4.83	5.50
Mid Parent heterosis	100.75**	77.33**	65.17**	61.87**	56.92**	52.62**	52.36**	49.58**	48.28**	45.34**	43.83**	43.28**
Inbreeding depression	31.58**	22.66**	24.56**	18.37**	18.29**	4.54**	4.00**	30.35**	15.90**	24.45**	10.58**	16.72**
sca effect F_1	0.42**	-0.12	1.15**	0.64**	0.15	0.27*	-0.17	0.67**	-0.18	-0.08	0.22*	0.47**
F_2	0.001	-0.06	0.27**	0.10	0.01	1.03**	0.07	0.35**	0.31**	-0.44**	0.13	0.07
sca effect F_1 in other traits	IV,VII,X,XI,XII	I,V,VII, VIII	IV,V,VII, XI	VI,VII,VIII, XII	IV, X, XII	IV,VI, VII,XI, XII	VIII	IV,V,VIII, XI	II,IV,XI, XII	IV,X,XI	I,VI,VII,	V,VII,VIII
F_2	VI,VIII,XI,XII	I,VII,IX	----	III,VI,VII,XI	IV,VI,XI	I,VI,VIII, X	XI	VIII	VIII	XI	----	IV,IX,XI
gca effect P_1	-0.36**	-4.55**	-0.45**	-0.36**	-0.60**	-0.60**	-0.45**	-0.60**	-0.45**	-0.36**	-0.36**	-0.45**
based on F_1 P_2	-0.45**	-0.63**	0.29**	-0.19**	-0.63**	-0.19**	-0.19**	-0.11**	-0.60**	0.29**	-0.11**	-0.22**
gca effect P_1 based on F_2	-0.40**	-0.54**	-0.54**	-0.40**	-0.68**	-0.68**	-0.54**	-0.68**	-0.54**	-0.40**	-0.40**	-0.54**
P_2	-0.54**	-0.36**	0.36**	-0.06**	-0.36**	-0.06**	-0.06**	0.04*	-0.68**	0.36**	0.04	0.67**
Desirable heterotic performance in other traits	I,IV,V,VI,VII, VIII,IX,X,XI, XII	IV,V,VI, VII,VIII, IX,X,XI, XII	I,IV,VI,VII,VIII,IX,X, XI,XII	IV,V,VI,VII, VIII,IX,X,XI, XII	I, IV,VI, VII,VIII,IX,X,XI, XII	I,IV,V,VI, VII,VIII, IX, X, XI,XII	IV,V,VI, VII,VIII, IX,X,XI, XII	I,IV,V,VI, VII,VIII, IX,X,XI, XII	I,IV,V,VI, VII,VIII, IX,X,XI, XII	I,IV,VI,VII, VIII,IX,X, XI,XII	IV,V,VI, VII,VIII, IX,X,XI, XII	IV, V, VI,VII, VIII, IX, X, XI,XII

Table Contd.....

Most heterotic crosses with rank	Shubhra/ DPL-21	DPL-21/ Garima	Neelam/ RLC-6	Neelum/ LMH-62	Shubhra/ KL-43 (17)	Neelum/ Sweta	LMH-62/ DPL-21	Neelum/ DPL-21	J-23/ RLC-6	Neelum/ Shubhra	DPL-21/ LCK-88062
Mid Parent value	4.30	5.31	4.89	6.56	4.75	4.74	5.90	3.03	4.77	4.94	5.10
Mid Parent heterosis	40.93**	39.88**	39.05**	36.95**	35.64**	32.26**	28.54**	28.06**	27.86**	25.64**	25.50**
Inbreeding depression	-35.92**	13.88**	22.63**	37.84**	2.23**	17.15**	17.24**	-13.42**	7.28**	13.78**	6.08**
sca effect F_1	0.13	0.61**	0.58**	0.93**	0.09	0.23*	1.10**	0.01	0.40**	0.15	0.34**
F_2	-0.12	-0.80**	0.32**	-0.37**	-0.17**	-0.16*	0.40	-0.23***	0.26**	0.41**	-0.20*
sca effect in other traits F_1	III,V,VII,XI	IV,V,VI, VII,X,XI	IV,VI,XI,X II	V, VII,XII	VIII,X,XII	I,II,,VI, XI,XII	IV,X,XI, XII	I,VII,	V,VII, XII	II,IV,XI,XII	I,X,XII
F_2	I,IV,V,VII, IX	XI	XI,XII	IV	III,	III,IX,X	III,IX,XI	I	III	V,IX	VIII,IX,XI
gcaeffect based on F_1 P_1	-0.36**	-0.60**	-0.26**	-0.26**	-0.36**	-0.26**	1.75**	-0.26**	-0.11**	-0.26**	-0.60**
P_2	-0.60**	-0.22**	-0.19**	1.75**	-0.63**	-0.45**	-0.60**	-0.60**	-0.19**	-0.36**	0.29**
gca effect based on F_2 P_1	-0.40**	-0.68**	-0.10**	-0.10**	-0.40**	-0.10**	1.05**	-0.10**	0.04*	-0.10*	-0.68**
P_2	-0.68**	0.67**	-0.06**	1.05**	-0.36**	-0.54**	-0.68**	-0.68**	-0.06**	-0.40**	0.36**
Desirable heterotic performance in other traits	I,VI,VII, VIII,IX,X, XI,XII	I,IV,V,VI, VII, VIII, IX, X, XI,XII	IV,V,VI, VII,VIII,IX, X, XI,XII	V,VI, VII, VIII, IX,X, XI, XII	I,IV,V,VI, VII, VIII, IX, X, XI	IV,V,VI, VII,VIII,IX, X,XI,XII	I, IV,V, VI, VII, VIII, IX, X, XI, XII	I,IV,V,VI, VII,VIII, IX,XI,XI, XII	IV,V,VI, VII,VIII,IX, XI,XII	IV,V,VI, VII,VIII,IX, X,XI,XII	I,VI,V,VI, VII,VIII,IX, X,XI,XII

Note :- (I) Days to 50 % flowering, (II) Days to maturity, (III) Plant height (cm), (IV) Technical plant height (cm), (V) No. of tillers/plant, (VI) No. of branches/plant, (VII) No. of capsules/plant, (VIII) No. of seeds/capsules, (IX) 1000-seed weight (g), (X) Harvest index (%), (XI) Fibre yield/plant (g), (XII) Oil content (%).

* Significant at p = 0.05   ** Significant at p = 0.01